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FISHER BIOLOGY AND MANAGEMENT IN THE WESTERN UNITED STATES

A Literature Review and Adaptive Management Strategy

(VERSION 1.2)

Prepared for

**the USDA Forest Service Northern Region
and
the Interagency Forest Carnivore Working Group**

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PREFACE

This document was prepared for the Interagency Forest Carnivore Working Group (Working Group) to synthesize information on fisher (Martes pennanti) biology and to provide an initial direction for management of fishers in the western United States. We consider this a working document (Version 1.1) requiring frequent updates and revisions as more information becomes available, and as the assumption and hypotheses presented are tested. We hope this effort will stimulate further discussion and research on the management and conservation of fishers in western habitats.

Part I reviews the biology of the fisher. The literature review prior to 1989 was taken primarily from Banci (1989), with permission from the British Columbia Ministry of the Environment, Wildlife Branch and V. Banci. While the focus is on the fisher occupying western habitats, we often relied on the more extensive knowledge of eastern populations to lend insights into western populations of fishers.

Part II presents a strategy for habitat and population management in the western United States. As an adaptive management strategy, revisions should be made frequently as more information becomes available on fishers in western habitats and for populations within various physiographic regions. The strategy has a hierarchical approach, with 6 scales, from continental to individual forest stand.

Parts III and IV are an annotated bibliography and a set of reference papers, respectively. The majority of the annotated bibliography prior to 1989 has been taken from Banci (1989). Part IV contains published papers and unpublished reports on fisher which may provide additional information. No attempt was made to reproduce theses or dissertations due to the length of these documents.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

Fishers historically occupied much of the forested habitats of Canada and the northern United States. Populations declined in the early twentieth century, probably due to habitat loss from settlement and logging, overtrapping, and predator poisoning. Although many eastern populations have recovered, western populations have remained at low numbers or are absent throughout most of their historic range in California, Oregon, Washington, Idaho, Montana, and British Columbia.

Description

The fisher belongs to the Mustelidae family and shares the genus Martes with the American marten. Although 3 subspecies have been proposed, additional analyses have not supported the designations. Fishers are similar in body form to weasels, and are the largest elongated terrestrial mustelid, as well as the most sexually dimorphic. Males (3-6 kg) weigh approximately twice that of females (1.5-2.5 kg), and average 20% longer in body length, with males and females averaging 62 and 51 cm in length, respectively.

Reproduction

The fisher exhibits long-term (327-358 days) delayed implantation with an active gestation of 30 to 35 days. Females may breed at 1 year of age, and have their first litter at 2 years of age. Whelping occurs from late February to mid-April, and females breed 2-9 days later. Litter sizes are small, usually with 2-3 kits, though litters have ranged from 1 to 4 kits. Kits achieve independence at 16-20 weeks of age, and disperse in the late summer and early winter.

Ovulation rates, frequently reported as 73-100%, may over-estimate actual fecundity, as recent studies have shown denning rates to be between 34-54%. Reproductive success may be dependent on the physical condition of the females during the winter. There is evidence suggesting the reproductive potential of fishers in western habitats may be lower than that in eastern populations.

Food Habits

Fishers probably select prey on the basis of availability, and their diets are typically diverse. Staples in western fisher diets have been reported as snowshoe hare, ungulate carrion, sciurids, and voles. Prey presence and abundance may partially explain habitat use of fishers, as they may switch to more available prey species in the winter.

Mortality

In eastern populations, fishers appear to have few predators except man. Although predation in most western populations also appears low, there are more reported incidences of mortality due to predation. Intraspecific strife, particularly in males, may contribute to natural mortality. Although a variety of endo- and ecto-parasites infest fishers, few have ill effects.

Fishers are susceptible to trapping, and are frequently caught in sets for other furbearers. Additionally, populations are vulnerable to trapping, as even light pressure may cause local extinction. Western fisher populations may have lower natality and higher natural mortality rates as compared to eastern populations. Consequently, western

populations may be more susceptible to over-trapping. It has been suggested that incidental captures may limit population growth in some areas.

Home range

Males typically maintain larger home ranges, which typically encompass 1 or more smaller female home ranges. Home range estimates have ranged from averages of 2.7 to 40.8 km^2 for females and averages of 15.0 to 85.2 km^2 for males. Fishers in the northern Rocky Mountains appear to maintain larger home ranges than fishers in eastern habitats, possibly due to a lower productivity of western habitats. Generally, females have shown temporal stability in home-range size, whereas males temporarily abandon their home ranges during breeding season in search of females.

Movements and Activity

Fishers are active both day and night, with some tendency for increased activity during crepuscular hours. A shifting of activity in response to environmental conditions, such as snow conditions or prey availability may occur. Inactivity after large meals or during extreme weather has been noted.

Fishers are capable of travelling relatively long distances in short periods. Males in particular make long distance movements during the breeding season. Some of the longest reported distances moved by fishers have been from translocated individuals.

Habitat Use

Although fisher are selective in their use of habitats, home ranges typically encompass a diversity of plant communities. In the west, fishers are generally found in conifer-dominated forests containing a diversity of habitat types and successional stages. Fishers are closely associated with forested riparian areas which are used extensively for foraging, resting, and as travel corridors.

Although fishers have been found to prefer mature and old-growth coniferous forest stands in most western studies, they also utilize a variety of earlier successional stages. Most studies have reported that fishers prefer forests with continuous cover, though some use of shrubby clearings can occur during certain seasons. A broader range of habitats may be used for hunting than for resting. Potential barriers to dispersal include large rivers, mountain divides above timberline, and open-canopied habitats.

Fishers appear opportunistic in their use of resting sites, with hollow logs, tree cavities and canopies, snags, rocks, ground burrows, and brush piles frequently used. Witches brooms in the canopy of large diameter trees are commonly used by fishers. Natal dens are most often in cavities of live or dead trees. The absence of hardwoods in western habitats may limit the availability of suitable tree cavities for natal dens.

Most studies have found fishers tolerant of moderate degrees of human activity within their habitats, including low density housing, farms, roads, and small-scale logging activities. Indirectly, human activities may lead to negative impacts on fishers through removal or fragmentation of high quality habitat, and increased trapping access.

Population dynamics

Little is known about the composition of fisher populations and the temporal stability of their spatial systems. Harvests reflect the abundance and vulnerability of sex and age classes and the effort expended by trappers. Males are more vulnerable to trapping because of their larger home ranges and movements. As trapping pressure increases, harvest will more closely reflect the true population composition. Males typically dominate the harvest

when trapping pressure is light, and the proportion of females increases with increasing trapping pressure. Juveniles typically comprise the largest segment of the harvest because of their greater abundance and movements.

Although data are few, densities estimated for western populations are much lower than estimated densities for eastern habitats. Because of intra-sexually exclusive home ranges, densities are a function of home range size. The large home ranges and low densities found in western populations may be a result of relatively lower productivity of the habitat, as compared to eastern habitats.

Population and metapopulation status in western habitats

In the western U.S., fishers are limited to the peninsular mountain ranges of the Pacific Coast and Rocky Mountains, forming the southern margins of a larger continental distribution. The peninsular populations may be acutely susceptible to extinction because of their location at the margins of their geographic distribution.

Fishers have been shown to selectively use habitats; it is likely these habitats are patchily distributed in modern landscapes and extant populations of fishers are widely-spaced and fragmented. Little is known of the dispersal and colonization capabilities of fishers, or the degree in which present populations are inter-related.

Management strategy

Planning for the long-term viability of fishers in western habitats will require both population and habitat management, but data is lacking to develop an in-depth conservation strategy, and it may be cost-prohibitive to acquire the needed information. A coarse-filter or ecosystem approach, across a hierarchy of landscape units, may be a more reasonable alternative. The present guidelines are meant to provide interim direction for fisher management until an ecosystem approach can be developed and effectively implemented. This management strategy incorporates multiple scales, from maintenance of genetic linkages between metapopulations to the management of resting or foraging habitat within a forest stand. The guidelines are adaptive, meaning that information must be continually collected and used in an iterative process to improve the probability of successful management. The overall goal is to maintain fisher populations with high persistence probabilities across their historic range in western North America. This goal may be achieved through meeting several objectives: 1) manage for the continued distribution of fishers throughout their current range; 2) manage habitats so that extant subpopulations have the opportunity to demographically interact; 3) manage for the restoration of habitats and populations within the fishers' historic range; and 4) inventory, monitor, and conduct research to facilitate adaptive management.

At the largest, or continental landscape unit, the overall goal of the management strategy is to demographically and genetically link the Pacific and Rocky Mountain populations to the Canadian population. The historic and current distribution of fishers in southern British Columbia and the northern portion of the western U.S. must be assessed prior to recovery or management of populations and linkage zones.

Within a physiographic region such as the Sierras or the Northern Rockies, the overall goal is to maintain or recover the fisher throughout its historic range, and to maintain or recover the suitability of potential habitats. Objectives required to meet this goal include maintaining genetic diversity through preservation or restoration of genetic linkages between metapopulations, identification of potential recolonization or augmentation areas to function as stepping-stone populations, maintenance of sensitive-linkage zones and reduction of mortality and vulnerability factors within these critical corridors; and the prevention of induced ecological barriers.

At the physiographic area landscape scale (e.g., northern Northern Rockies), the overall goal is to maintain or restore metapopulation viability, as represented by a group of interacting subpopulations with finite lifetimes. To achieve this, it will be necessary to maintain the viability of subpopulations and ensure the linkage of subpopulations to allow demographic exchange. Additionally, it is recommended that a central subpopulation be managed as a reservoir, containing a refuge to function as a source of dispersers for the surrounding subpopulations.

At the major watershed landscape scale (approximately 500-1300 km^2), the overall goal is to maintain the short-term viability of the subpopulation. Objectives required to meet this goal include the maintenance or restoration of fisher habitat across the watershed and the maintenance of connectivity between home ranges.

At the subdrainage level (approximately 25-250 km^2) the overall goal is to maintain functional home ranges. This is achieved through the maintenance of the quality and connectivity of suitable habitats within a subdrainage.

At the forest stand scale, the overall goals are to maintain stand structure and composition suitable as resting and foraging habitat. These goals are achieved through managing of existing preferred and suitable habitats, designing treatment of stands managed for timber production to allow rapid recolonization of prey species, and conservatively managing forested riparian areas.

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"The fisher is by far the largest of the martens as well as one of the handsomest, a long-bodied, vigorous hunter, with the agility of a sable and the strength of a wolverine. Possessing many of the habits of the pine marten, he has a shrewder intelligence and greater boldness in hunting; for he manages somehow to kill the Canadian porcupine in defiance of his spine armour, and will circumvent a savage old she bear and kill her cubs while she is away. It is said that fishers of the Rocky Mountain region even kill young grizzlies in this manner." (Stone and Cram 1905).

INTRODUCTION

Fishers historically occupied much of the forested habitats of Canada and the northern United States. Fisher populations declined in the early twentieth century, probably due to habitat loss from settlement and logging, overtrapping, and predator poisoning (Banci 1989). Although some regions of Canada experienced population reductions or extirpation, the majority of the population declines occurred in the United States. By the 1930s, only small remnant populations remained in the U. S., primarily in a few northeastern states (Maine, New York, New Hampshire, Minnesota), as well as in California (Powell 1982). Trapping closures, the reforestation of eastern farmlands, and reintroduction efforts have allowed fisher populations to recover in much of the species historical range in the eastern portion of the United States.

Populations of fishers have remained at low numbers or are absent throughout most of their historic range in California, Oregon, Washington, Idaho, and Montana. The fisher population in British Columbia has also been at low numbers, indicating that fisher in general, are not thriving in modern western habitats. Currently, the fisher is considered the furbearer of highest management concern in British Columbia (Banci, pers comm.). In the western United States, all states except Montana have closed trapping seasons on the fisher and the Forest Service considers the fisher a sensitive species that requires special management consideration through most of its western distribution. The Pacific coast population was petitioned for listing as endangered under the Endangered Species Act (Central Sierra Audubon Society et al. 1990), and is considered a state species of special management concern in California, Oregon, and Washington.

DESCRIPTION

Taxonomy

Martes pennanti (Erxleben 1777)

Order Carnivora, Suborder Fissipedia, Family Mustelidae

Common names: fisher, fisher cat, pekan, black cat, fisher marten, pekan marten, Pennant's cat, Pennant's marten, tha-cho (Chippewa), Otchock or Oochik (Cree).

The genus Martes occurs in 3 subgenera, Martes, Pekania, and Charronia. Martes pennanti is the sole representative of the subgenus Pekania (Anderson 1970, 1991). It differs from the true martens by its large size and an external median rootlet on the fourth upper premolar (absent in the subgenera Martes and Charronia).

Three subspecies have been designated. M. pennanti pennanti is the eastern variety identified by Erxleben in 1777 (Peterson 1966), and occurs east of the Manitoba-Ontario border (Goldman 1935). Rhoads (1898) designated the West Coast subspecies M. pennanti pacifica using only 5 skulls and 2 skins. He characterized it as having a large size with some color differences. This subspecies, known as the "Pacific" fisher, ranges from Alaska to California (Rhoads 1898). M. pennanti columbiana, the British Columbian fisher, was designated by Goldman (1935) from 95 specimens. Distribution was described as the Rocky Mountain Region from northern British Columbia, south to central Idaho and east to southern Canada, grading to M. p. pennanti in Manitoba (Goldman 1935).

Subsequent analyses have not supported any of these geographic subspecific designations (Grinnell et al. 1937, Coulter 1966). Grinnell et al. (1937) re-examined pelts and skulls from the western and eastern varieties and did not find characteristics warranting subspecific designation of the Pacific fisher. Hagmeier (1959) re-examined all 3 subspecies using 321 skulls. He noted that geographic variation was slight and that the subspecies were "lightly characterized". Anderson (1970) examined skulls, teeth, and postcranial skeletons of 1,941 fossil and recent fishers in east and west populations and concluded that subspecific designations were unwarranted.

Evolution

Ancestors of fishers were probably small, arboreal, forest-dwelling carnivores that did not leave a well-defined fossil history, and little is known of the evolution of this species (Powell 1982, Anderson 1991). The first fishers, M. palaposinensis, appeared in China in the late Pliocene. This species was probably ancestral to first American species, Martes divuliana, and to the modern fisher (Anderson 1991). The earliest fossils of M. divuliana found in North America were dated back to the middle Pleistocene period. The species probably travelled to the continent via the Beringial land bridge. Fossil records of M. divuliana are found only during the middle Pleistocene, while M. pennanti fossils do not occur until the late Pleistocene. This gap in the fossil history leads researchers to believe that M. divuliana was not a direct ancestor of the modern day fisher, but an ecological forerunner (Anderson 1970).

Description

Fishers are similar in body form to weasels and are the largest elongated terrestrial mustelid. The fur color varies from very dark brown to blackish brown, typically being the darkest on the rump and lower back. The head and shoulders may have a grizzled grayish appearance due to tricolored guard hairs, especially in the older males (Coulter 1966). Irregular white patches are often present on the chest and underside. The head is broad and flat, narrowing to a pointed face and nose; the ears are rounded, low and broad, and are relatively smaller than in pine martens.

Fishers are the most sexually dimorphic of all mustelids (Banci 1989). Males (3 - 6 kg) weigh approximately twice as much as females (1.5 - 2.5 kg), but can weigh up to six time more. Body length averages 20% longer in males than females, with adult males and females averaging 62 and 51 cm in length, respectively (Douglas and Strickland 1987). Powell (1982) found the size of fishers varied geographically, but Douglas and Strickland (1987) found a similar degree of variability within a single geographic region. The largest fisher recorded was a male from Maine weighing over 9 kg (Blanchard 1964).

Despite the high degree of sexual size dimorphism, the feet of males and females overlap in size, and sex cannot be determined from tracks (Coulter 1966, Johnson 1984). There are 5 toes and toe pads on each foot, with claws that are retractable but not sheathed (Powell 1982). A central pad has tufts of short hair which may be associated with glands (Powell 1982). Fishers can rotate their hindlimbs to permit a head-first descent of trees (Coulter 1966), a factor which facilitates arboreal activity (Douglas and Strickland 1987). However, reports of the arboreal activity of fishers apparently have been exaggerated (deVos 1951, Coulter 1966, Powell 1980a, Raine 1981). Any enhanced ability of the forelimb for arboreal locomotion is likely a secondary function (Leach 1977).

The dental formula is the same as is found in wolverine and American marten: incisors, 3/3; canines, 1/1; premolars, 4/4; molars 1/2; for a total of 38 teeth. Skull size can distinguish the fisher from the marten, with fisher skulls measuring at least 9.5 cm. Additionally, the fisher has an exposed external median rootlet on the upper carnassial tooth (Douglas and Strickland 1987).

DISTRIBUTION

Fishers (Martes pennanti) occur only in North America, primarily within the boreal forests spanning the northcentral portion of the continent. The species also occurs in the Northeastern Mixed Forest, the Pacific Coastal Forest, and the Coniferous Forest vegetation zones of Allen (1987). In the recent past, the distribution of the fisher was described as extending from Nova Scotia to Latitude 62° on the Mackenzie River, west to the Pacific Ocean, with 3 arms extending south and one arm extending north (Seton 1926). An arm extended to South Carolina on the east coast, another arm through the Rocky Mountains to Wyoming, and third arm extended along the Pacific mountain ranges to central California. The northern arm extended along the Pacific into the interior of British Columbia, and represents the most northerly distribution of the fisher. (Seton 1926). Fisher do not occur in Alaska or on coastal islands.

Within the western United States, Maj and Garton (1993) mapped the distribution of fishers based on records spanning from the 1800's to the present. Records were grouped into 3 periods: 1800's-1961 when the western habitat of the fisher was relatively unmodified; 1962-1981, when fur-trapping and habitat modification occurred at an elevated level; and 1982-1993, depicting the current fisher distribution (Figure 1).

LIFE HISTORY

Reproduction

Delayed implantation is common among the Mustelidea, and occurs in all three of the North American forest mustelids (fisher, marten, and wolverine). The three mustelids exhibit long-term delayed implantation (240 - 358 days long; Mead 1989), with the delay in the fisher ranging from 327 to 358 days (Enders and Pearson 1943, Eadie and Hamilton 1958, Wright and Coulter 1967). The functionality of this trait is unknown; the delay may allow breeding to occur at an optimal time of the year, while still allowing the kits to be born early (Mead 1989, Arthur and Krohn 1991). Early parturition would be advantageous in allowing maximum growth before the fall dispersal of the juveniles.

Reported whelping dates for captive fishers range from late February to mid-April (Hall 1942, Hodgson 1937). Most documented parturition dates in wild fishers are from mid-March into early April (Paragi 1991, Powell 1977, Leonard 1986, Hamilton and Cook 1955). The length of active gestation is between 30 and 35 days (Hall 1942, Coulter 1966). Based on the uniform development in the skull and skeleton, and the uniform degree of skull suture closure in the juveniles collected in November and December,

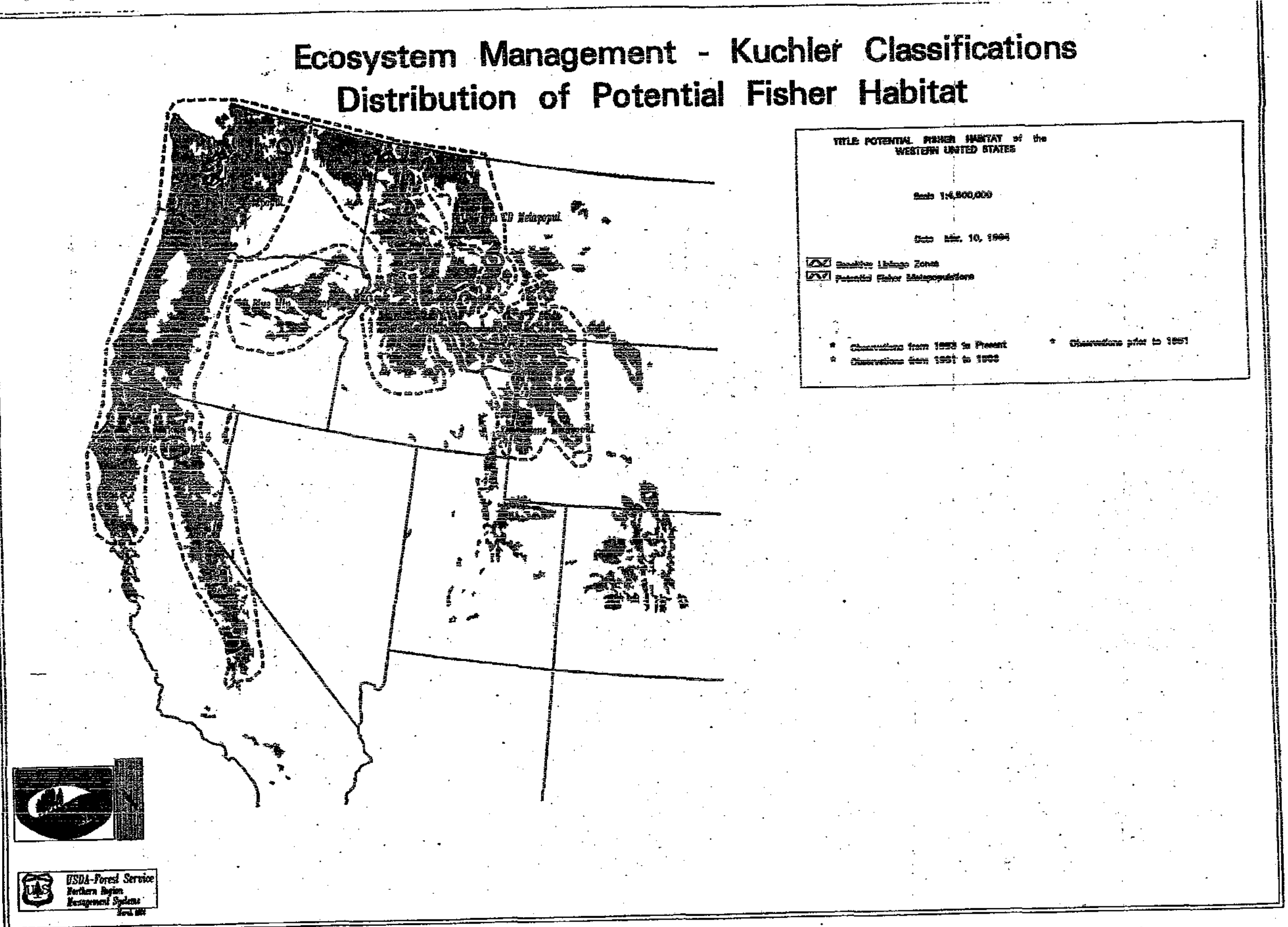

Figure 1. Distribution of recorded fisher sightings and potential fisher habitat in the western United States. See text (Part II) for explanation of habitat classification, and metapopulation and sensitive linkage zone determination. Fisher records are from Maj Garton (1993).

Leonard (1980) felt there was little within-year variability in birth dates in Manitoba. The timing of blastocyst implantation, and subsequent parturition is synchronized within most carnivore populations through pineal responses to photoperiodic timing (Mead 1989). Variability seen between years may be an influence of annual fluctuations in population densities, weather, or resources abundance.

Breeding occurs from 2-3 (Laberee 1941) to 3-9 days (Hodgson 1937) after parturition. Dates of breeding on fur farms were 26 March - 23 April in Ontario (Hodgson 1937) and 5 April - 27 April in British Columbia (Hall 1942). Estimated dates of estrus for wild fishers in Ontario were late March to early April (Douglas and Strickland 1987). Hodgson (1937) reported that a female not bred during the first estrus may have a second heat in 2-3 days. Ovulation is assumed to be induced at the time of breeding, as has been found in other species of mustelids (Ewer 1973).

Fishers are born altricial, with the eyes opening at 7-8 weeks (Coulter 1966, Powell 1982). The kits can crawl by the end of the eighth week, they can walk by the ninth week, and are able to climb by the tenth week (Coulter 1966). Kits are independent at 16-20 weeks (Coulter 1966, Powell 1976). By 20 weeks, they achieve adult length, but not weight, and sexual dimorphism is evident (Douglas and Strickland 1987). Kelly (1977) reported fishers in New Hampshire reached total adult length in their first 32-48 weeks. Kits are not fully grown by the time they disperse, between late summer and early winter (Coulter 1966).

Testes increase in weight through the winter, in preparation for breeding (Leonard 1980, Douglas and Strickland 1987). By 1 March - 4 April, abundant sperm are present in both the testes and epididymides (Wright and Coulter 1967). The length of time that males remain spermatic is unknown. A trapped male was spermatic on 4 April in Maine (Wright and Coulter 1967), and spermatic males were reported during May in Ontario (Douglas and Strickland 1987).

Males are spermatic at 11-12 months of age and their testes are adult size by March (Wright and Coulter 1967, Leonard 1986, Douglas and Strickland 1987). However, the bacula of adults are heavier during March and April, and differ in shape from the bacula of juveniles (Douglas and Strickland 1987). Because of these differences, juvenile males may be unable to induce ovulation in females (Douglas and Strickland 1987). As the baculum develops under the influence of androgen (Wright 1950), Wright and Coulter (1967) hypothesized that the juvenile bacula would develop into the adult type by late spring. Evidence of adult male aggression towards juvenile males (Douglas and Strickland 1987) suggests that even if juveniles are physiologically capable of breeding, adult males may aggressively prevent trespasses, or juveniles may not be socially acceptable to females. Behaviorally, juveniles may not respond to the breeding season; juvenile males reintroduced in Montana did not increase movements or home range size during the breeding season, as is typical of adult males (Heinemeyer 1993).

Reproductive Rates. Females fishers have 1 litter per year. Females may breed at 1 year, and have their first litter at 2 years of age (Coulter 1966, Wright and Coulter 1967, Leonard 1986, Douglas and Strickland 1987). In Montana, females may not breed until 2 years of age (Aune and Schladweiler 1993). Litter sizes are small, usually ranging from 1-4, with 2-3 being the norm (Table 1).

Most estimates of fisher reproductive potential has been based on corpora lutea counts (Eadie and Hamilton 1958, Wright and Coulter 1967, Kelly 1977, van Nostrand 1979, Shea et al. 1985, Leonard 1986, Douglas and Strickland 1987, Kuehn 1989), blastocysts counts (Hamilton and Cook 1955, Eadie and Hamilton 1958, Wright and Coulter 1967, Kelly 1977, and Douglas and Strickland 1987), or from litter sizes of captive fishers (Hodgson 1937, Hall 1942, Coulter 1966, Powell 1982, Leonard 1986). Reported corpora lutea counts range from 2.0 to 3.7 (Table 2). Corpora lutea or blastocyst counts may overestimate actual fecundity, as denning rates have been lower than reported ovulation rates (Leonard 1980, Paragi 1990). In Maine, average denning rate was

Table 1. Fisher litter sizes based on known litters of captive or wild animals or from *in utero* counts.

Location	Litter size mean ± sd	Range	n	Type[a]	Source
Montana	3		1	W[b]	Roy 1991
California	2.7±0.72	2-4		W	Grinnell et al 1937
		1-4	21	C	Hall 1942
	2.5	1-4		W	Hamilton 1957
Maine	2.0-2.2	1-3	12	W	Paragi 1990
	3.3	3-4	9	I	Wright and Coulter 1967
	3.0	3	2	C	Coulter 1966
	3.4±0.52	3-4	11	I	Coulter 1966
Ontario	3.09		45	I	Douglas and Strickland 1987
Manitoba	4[c]		1	W	Leonard 1980
	3.0		3	I	Leonard 1980
Michigan	2		1	W	Powell 1977
Maine	3.3	3-4	9	I	Wright and Coulter 1967

[a] W = wild, C = captive, I = *In utero*.

[b] From a female transplanted from Minnesota the previous fall

[c] Two young were confirmed, 4 young were suspected

estimated between 34% (Arthur and Krohn) and 54.5% (Paragi 1990). Reported ovulation rates from previous studies of corpora lutea or blastocyst counts in Maine indicated 95-97% pregnancy rates (Shea et al. 1985, Douglas and Strickland 1987), suggesting implantation rates are lower than the ovulation or fertilization rates. Paragi found that the proportion of females with placental scars (75%, n=20) more closely corresponded to the observed denning rate than did blastocyst counts. But, Strickland and Douglas (1987) found that placental scars do not persist, and when available, scar numbers are usually less than the number of fetuses (Banci 1989). Coulter (1966) counted 2.93±0.78 (n=27) placental scars and 3.45±0.52 (n=11) fetuses.

Delayed implantation provides the option of interrupting pregnancies if the female is not in sufficiently good condition during winter. Arthur (1988b) suggested that reproductive success was dependent on the physical condition of females during fall and winter. Paragi (1990) believed that denning rate is affected by prey availability and female age. Banci (1989) felt that denning rates of fishers inhabiting less productive habitats or where severe winters and deep snow levels are present may be lower than for fishers in other habitats. Though data are few, corpora lutea counts are lower in Rocky Mountain populations as compared to eastern populations (Table 2).

There is little information on age-specific reproductive rates in fishers. In Manitoba, barren females were primarily "young" fishers (Leonard 1986), however ages were not given. Douglas and Strickland (1979, 1987) did not report any age class differences in the proportion of barren females in Ontario. However, the oldest ages (>8.5 years) appeared to have a lower percentage of pregnant females (M. Strickland, in Banci 1989). Shea et al. (1985) found a positive correlation between age class and fecundity for fishers in Maine. Counts of corpora lutea from 4-8 year old females were significantly higher than 2-3 year olds, which were significantly higher than yearlings. Denning rates peaked at 4 years of age (Paragi 1990). Douglas and Strickland (1979, 1987) have provided the most extensive information on age-specific natality based on corpora lutea counts. Productivity of Ontario

Table 2. Average numbers of corpora lutea counted in the ovaries of adult females

Corpora Lutea mean ± sd	n	Time Period	Location	Source
2.17±1.17	10	1977-1993	Montana	Aune and Schadweiler 1993
2.0	5	1985-1988	Idaho	Jones 1991
3.2	18	1988	Maine	Paragi 1990
3.0	24	1989	Maine	Paragi 1990
3.0±1.04	141	1978-1981	Maine	Shea et al. 1985
3.3	44	1950-1964	Maine	Wright and Coulter 1967
3.3±0.52	11	1977-1979	Maine	Coulter 1966
3.3	994	1972-1983	Ontario	Douglas and Strickland 1987
3.5	13	1972-1978	Manitoba	Leonard 1986
3.7	12	1976	New Hampshire	Kelly 1977

females peaked at approximately 5.5 years of age. Although sample sizes were small, natality appeared to be lower for older females.

Reproductive behavior. Coulter (1966) and Powell (1982) raised fisher litters in captivity and documented kit development. Grinnell et al. (1937) and Hamilton and Cook (1955) provided anecdotal information on aspects of fisher reproduction. With radiotelemetry, information on the reproductive biology of wild fishers has become available. The denning period lasts for 8-12 weeks (Arthur and Krohn 1991, Paragi 1990, Leonard 1980, P. W. Rego, in Paragi 1990), which corresponds to the duration of lactation in captive fishers (Coulter 1966, Powell 1982). Females may move their kits periodically to new dens. A single den was used by a female fisher with kits in Manitoba (Leonard 1980), 2 dens were used by each of 2 females in Connecticut (P.W. Rego, in Paragi 1990), 1-3 dens were used by females in Maine in 1986-87 (Paragi 1990, Arthur and Krohn 1991).

A female reduced her home range size immediately prior to parturition in mid-March; her home range increased through June and remained fairly stable through the summer months (Kelly 1977). In January, the female's home range increased, and Kelly (1977) hypothesized this was due to either freedom from dependent young, or anticipation of parturition. Leonard (1980, 1986) monitored the movements and activities of an adult female through two reproductive seasons and found that movements were short during active pregnancy. During the early denning period, the female left the den for only short periods of time and only during the warmest hours of the day. As the denning progressed, the female left the den for longer periods until only one hour a day was spent with the kits just prior to the end of the denning period. Arthur and Krohn (1991) monitored the activity of 14 denning and non-denning adult females and found that denning females were active a greater percentage of the day than were nondenning females. Paragi (1990) also monitored the activities of denning female fishers in Maine, but found that large individual differences in activity levels and timing obscured possible patterns.

Food Habits

Fishers proabably select prey on the basis of availability and their diets are typically diverse. Although there are several estimates of fisher diets, most are for eastern populations and few data are available for fishers in western North America. Staples in described fisher diets include snowshoe hare, porcupine, ungulate carrion, sciurids, voles, and birds (Banci 1989). Diets of fishers in Pacific coastal states consisted of porcupine,

sciurids, woodrats, mice, marmots, mountain beavers, quails, and grouse (Ingles 1965). Diets described for fishers in California were similar but included chickarees (Grinnell et al. 1937). The predominant prey in 8 stomachs of fishers from California was false truffles, a subterranean fungi (Grenfell and Fasenfast 1979). Other food items included white-footed mice, shrews, moles, and sciurids. Mammalian prey items, excluding ungulate carrion, having the highest frequency of occurrence in the diet of Idaho fishers were snowshoe hares, red squirrels, red-backed voles, and beaver (Jones 1991). Roy (1991) reported fishers reintroduced into Montana consumed primarily snowshoe hare and carrion, supplemented by a variety of small mammals. Rodents (60% mice, 40% larger rodents) and lagomorphs were primary prey items for fishers trapped in Montana between 1977 and 1993 (n=26; Aune and Schladweiler 1993).

Powell (1982) suggested that small mammals and sciurids were over-represented in diet studies and were consumed fortuitously by fishers. Smaller prey species may have greater importance in the diet when less larger prey are consumed, i.e. when larger prey are unavailable (Banci 1989). The consumption of small mammals was negatively correlated with the consumption of snowshoe hare, suggesting that small mammals were an important alternate prey during periods of low hare availability (Kuehn 1989). In Manitoba, during a 3-year increase in the snowshoe hare cycle, the occurrence of small and medium-sized mammals in the diet decreased, while the proportion of hares increased (Leonard 1980, Raine 1981). During the peak in hare numbers, fishers ate 94% hare, 3% birds, and no sciurids or small mammals (107 scats) (Raine 1981). The next year, the start of the decline phase in the hare cycle, diets (53 scats) consisted of 63% hares, 19% birds, and small mammals and sciurids reappeared in the diet.

Scavenging is an important foraging behavior of mustelids, but is difficult to quantify. Ungulate carrion was a dominate food item in both studies in the northern Rockies (Jones 1991, Roy 1991). Carrion may be seasonally abundant, such as in winter or during ungulate hunting seasons. During a severe winter in Minnesota, deer mortality was high and provided an abundant food source for scavengers (Kuehn and Berg 1979). The incidence of deer in the diet of fishers that year increased to 31%, from 19% the previous year. The frequency of mice decreased from 14% to 4%, while the proportion of snowshoe hares remained constant at 36%. Powell (1982) noted that highway killed deer was a source of carrion unrelated to the hunting and trapping seasons, with peaks at different times of the year.

Not all scavenges of fishers consist of ungulates. Muskrats frozen out of their pushups in November and December were sources of carrion in Manitoba (Leonard 1980). Fishers also scavenged on hares, grouse, and red squirrels (Raine 1981).

Seasonal diets. Most diets described for fishers are for winter; few quantitative data are available for summer diets. Stevens (1968) provides the best information on annual trends. His study indicated an increased incidence of vegetation during summer and fall, especially fruits and nuts. Deer (carrion) in the diet peaked during winter and spring, consistent with patterns in ungulate mortality. The importance of snowshoe hare and sciurids increased over winter while the frequency of moles, shrews, and fruit decreased. Mice and birds were consumed all year. Summer diets are likely to be more varied because of the increased diversity of prey.

Diets of fishers in Maine were described using 3 seasons: autumn (late September - 30 November; n = 85), early to mid-winter (1 December - 31 January; n = 99), and late winter (1 February - early April; n = 48; Coulter 1966). Although representing a narrower time period, the results are similar to those of Stevens (1968). Stomachs of fishers trapped during fall and early winter had a greater variety of foods than those of fishers trapped in mid-winter. Of the 3 seasons, Coulter (1966) noted that autumn had the maximum potential types and abundance of prey. Consumption of snowshoe hares, deer, sciurids, and birds decreased from autumn to late winter, and there was a decrease in the

consumption of shrews during late winter. Frequencies of porcupines and mice did not differ among the 3 seasons (Coulter 1966).

Similarly, in Ontario foods consumed during November were most different from those consumed from December to February (Clem 1977a). Snowshoe hares and muskrats were eaten all winter. Frequencies of porcupine, sciurids and small mammals decreased during December, while the incidence of deer increased, possibly indicating a prey switch with a greater abundance of carrion. The consumption of birds, sciurids, and small mammals increased and the percentage of empty stomachs decreased as winter progressed. Thus, if foods were less diverse later in the winter, they weren't necessarily less abundant.

Prey presence and abundance may partially explain habitat use of fishers (Allen 1983, Raine 1983). In Idaho, a change in prey availability may have partially explained an observed shift in habitat use between summer and winter (Jones 1991). The fishers may have relied more on red squirrels in winter when voles become less available. Coulter (1966) also suggested that in Maine fisher predation of squirrels increased as winter progressed.

Sex and age differences. Few differences in diets were apparent between sexes of fishers in Maine (Coulter 1966), New Hampshire (Stevens 1968), and Ontario (Clem 1977a). However, in some localities and at certain times, females may consume a greater proportion of smaller prey, and they may be more efficient at finding food (7% empty stomachs for females vs. 20% for males in New Hampshire; Stevens 1968). In Manitoba, females consumed more snowshoe hare than males during 2 seasons (28-30% of diet for females, 8-17% for males), but samples were small (Leonard 1980). During the peak in the hare cycle, sexes did not differ in hare consumption (43% female, 55% male; Leonard 1980). Porcupine quills are found more frequently in males (Kelly 1977, Leonard 1980, Rego 1984, Strickland and Douglas 1987, Arthur 1987, Arthur et al. 1989). Diets of sexes may differ during summer and fall when females are providing for kits but these data are unavailable.

Energetics

Higher total energetic costs have been recognized in mustelid species that lack morphological adaptations for their cold habitats. Not only does the typical mustelid shape possibly result in higher maintenance costs, (Iverson 1972, Brown and Lasiewski 1972), but year-round short fur (Casey and Casey 1979, Chappel 1980) further increases the high rate of conductance. Furthermore, known lower critical temperatures (T_{LC}) of mustelid species are several degrees above normal winter ambient temperatures, indicating they may be in almost constant thermal stress. Winter thermoregulation in arctic weasels (Mustela rixosa and M. erminea) required twice the energy metabolism as in the summer, partly due to a T_{LC} of 25-30°C (Casey and Casey 1979). The T_{LC} of the marten was measured at 16°C (Buskirk et al. 1988). In contrast, the sympatric arctic fox (Alopex lagopus) and red fox (Vulpes vulpes) show T_{LC} of -40 (Scholander et al. 1950) and -10°C (Irving et al. 1955), respectively. Wintertime strategies of the marten include the ability to enter a shallow torpor and to select den sites which offer optimal thermoregulatory characteristics (Buskirk 1989). Although the T_{LC} of fishers is unknown, if it is similar to other weasel-shaped mustelids, behavioral or physiological mechanisms (such as inactivity and den site selection) may be used to compensate for morphological limitations in heat conservation. Long periods of inactivity have been noted during the winter (deVos 1952, Coulter 1966, Powell 1982). Average body temperature appears to respond to ambient temperatures and food intake levels in preliminary investigations of captive fisher, indicating potential behavioral (inactivity) or physiological (light torpor) responses to energetic stress (Heinemeyer, unpubl. data).

Energy budgets. Davison et al. (1978) estimated food intake and energy requirements for

captive fishers. Through feeding trials, he determined that coturnix quails and white-tailed deer provided the most energy of 4 prey groups. Snowshoe hares and small mammals had lower digestibilities but hares contributed the most protein. Davison (1975) hypothesized that hares were the best food for growing fishers because of the high conversion of dietary nitrogen to body tissue.

Powell (1979) developed an energy budget model that predicted daily energy expenditures of 200 - 450 kcal for free-living, radio-collared females. Powell and Leonard (1983) applied telemetry and snow-tracking data to the model and found that daily energy expenditure approximated the energy requirements predicted by Davison et al. (1978). These estimates are equivalent to 1 hare every 2 - 5 days, 1 porcupine a month, 1/4 - 1/2 kg of deer carrion a day, 1/2 - 1,1/2 squirrels a day, or 5 - 22 mice per day (Powell 1981). This model was later adjusted and applied to the energetics of a lactating fisher (Powell and Leonard 1983). The non-reproductive energy expended (by a 2.64 kg female) during early lactation was predicted to be 970 kJ/d when kits were 13-56 days old. Lactation required 542-1006 kJ/d, approximately 40% of the total energy expended. Other costs increased from 899 to 1330 kJ/d, due to an increase in activity by females when securing food for kits. When kits were 7 weeks old, 2270 kJ/d was required, 2.3 times the needs of a non-reproducing female fisher. Since weaning is incomplete until kits are at least 10 weeks old, energy expenditure could reach 2500-2900 kJ/d, almost 3 times the non-reproductive expenditure.

Powell and Leonard (1983) hypothesized that the female fisher may be restricted in body size by the ability to obtain enough food during lactation. If she was the size of a 4 - 5 kg male, with resulting larger young, she may have difficulty obtaining the extra daily energy needed for maintenance. This supports the theory that the extreme sexual dimorphism prevalent in mustelids is partially a result of selection for smaller female size to lower reproductive energy requirements (Erlinge 1979, Moors 1980).

Mortality

There have been few studies of fisher survival rates in the wild. In Maine, minimum summer survival rate of juveniles up to the trapping season was as low as 0.63, with average annual survival rates of 0.19 and 0.69 for juveniles and adult females, respectively (Paragi 1990). In Maine, 86% (43 out of 50) of the mortality of radio-collared fisher (n=76) was from legal trapping (40) and illegal shooting (3). Healthy, adult fishers are rarely subject to predation in eastern North America (Coulter 1966, Powell 1982), although there was one documented mortality due to coyote predation in Maine (Krohn et al. 1991).

Natural mortality may be higher for western fisher populations. All studies conducted in the west (Grinnell et al. 1937, Buck 1982, Mullis 1985, Jones 1991, Roy 1991, Heinemeyer 1993) have documented predation upon fishers. Two fishers were killed by mountain lions in California (Grinnell et al. 1937). Four of 21 fishers in northwest California may have been preyed upon (Buck et al. 1983), and 3 of 21 fishers in Idaho died from predation (Jones 1991). Roy (1991) and Heinemeyer (1993) documented high predation rates of fishers translocated from Minnesota and Wisconsin to northwestern Montana. Unfamiliarity with western predators and habitats, as well as the stress of transplantation, undoubtedly contributed to the initial high susceptibility to predation of the reintroduced fishers (Roy 1991, Heinemeyer 1993).

Douglas and Strickland (1987) cited intraspecific strife, particularly between adult and juvenile males, as a possible contributor to natural mortality. Pelt scarring was most frequently observed in juvenile males (53%, 163/307), and secondly in adult males (42%, 47/113) (Douglas and Strickland 1987). Rates were 16% (50/305) and 5% (7/153) for juvenile and adults females, respectively (Douglas and Strickland 1987). Leonard (1980) described the incidence of fractured zygomas in skulls of male fishers, an injury never observed in females. Aggression between adult and juvenile males is likely most frequent during the breeding season.

Although a variety of endo- and ecto-parasites infest fishers (reviewed in Powell 1982, Douglas and Strickland 1987), apparently very few have ill effects. Furbearers are not seriously compromised by parasitic infections other than sarcoptic mange (Addison et al. 1987). Mange is a contagious skin disease that can be a serious mortality factor under some conditions (Addison et al. 1987). Canine distemper is an invariably fatal viral disease that has been documented in fishers from New York (Monson and Stone 1976). Because routes of transmission are direct contact and by aerosol, the occurrence of distemper is primarily a function of densities (Monson and Stone 1981). As fishers typically occur in low densities, the incidence of this disease is likely to be low.

In any sample of live fishers or carcasses, a proportion is pierced by porcupine quills (Banci 1989). Quills carry no poisons or irritants and have no characteristics that could cause infections but injuries occur occasionally. deVos (1952), Hamilton and Cook (1955), Morse (1961), and Coulter (1966) cite instances in which quills have caused blindness in fishers when imbedded in the face. Powell (1982) reported of a quill imbedded in a fisher's chest which became infected and needed treatment. Fishers have developed techniques for predating upon porcupines, and probably receive fewer quills and suffer less serious problems then other predators (Powell 1982). O'Meara et al. (1960) suggested that porcupines were a possible transmission agent of sarcoptic mange.

Trapping mortality. Fishers are susceptible to trapping (Coulter 1966, Young 1975, Kelly 1977, Raine 1981, Powell 1982, Strickland et al. 1982) and are frequently trapped in sets made for other furbearers (Hamilton and Cook 1955, Coulter 1966, Weckwerth and Wright 1968, Young 1975, Jones 1991, Roy 1991). In Idaho, where fishers are protected, Luque (1983) estimated that at least 163 animals were inadvertently trapped over a 5-year period in sets made for marten, coyote, and possibly bobcat. In Montana, approximately 10% of radio-tagged reintroduced fishers were killed in traps set for coyote and marten (Roy 1991, Heinemeyer 1993).

Fisher populations are sensitive to trapping pressure, as even light trapping pressure may cause local extinction (Powell 1979, 1982). Coulter (1966) suggested that a fisher population would not be able to maintain itself if harvest exceeded 25-30% of the population. Jones (1991) speculated that in Idaho, incidental captures in sets designed for other furbearers may be limiting population growth. Incidental loss of translocated fishers to trapping may limit the success of the reintroduction effort in Montana (Roy 1991, Heinemeyer 1993).

Although there is little data, natality rates may be lower and mortality rates may be higher for fishers in western habitats than in habitats elsewhere in North America. Furthermore, the potential for over-trapping is higher when and where prey populations are low (Powell 1979). Consequently, fisher populations in the west may not be able to tolerate as high a trapping pressure as eastern populations. Even though trapping seasons are closed in most western states, incidental captures may limit population growth and partially explain the lack of population recovery in some western habitats.

Home range

Home range size is thought to be related to a variety of life history traits, and may be an indirect measure of the energy available to an animal (Lindstedt et al. 1986). For mammals in general, home range sizes have been reported to be inversely related to food supply (Harestad and Bunnel 1979). Marten (Soutiere 1979, Thompson and Colgan 1987), lynx (Ward and Krebs 1985), and bobcat (Litviatis 1986) home range sizes have been found to be related to resource availability and habitat quality.

Most estimates of fisher home ranges based on radio-telemetry have used minimum area or a related technique. Recent work has used statistical estimators such as harmonic mean or adaptive kernel analysis to predict home range areas. Home range estimates have

ranged from averages of 2.7 to 40.8 km^2 for females and from averages of 15.0 to 85.2 km^2 for males (Table 3). This variability is probably due to differences in estimation techniques, as well as true ecological differences. Comparison of home range estimates between studies must be done cautiously because of variations in the sampling regime and data analysis (Landré and Keller 1984).

The home range size of an individual should indicate local site conditions in asocial, territorial carnivores such as martens and fishers (Van Horne 1983, Buskirk and McDonald 1989). Unfortunately, the large within-site variability in estimated home range sizes of fishers in most studies obscures potential regional differences in space requirements.

Fisher home ranges in Idaho were 2 to 11 times larger than other reported fisher home range estimates (Jones 1991). Jones (1991) proposed that the larger home ranges were a function of less productive western habitats and a lower productivity compared to more eastern populations. Heinemeyer (1993) standardized home range analyses by recalculating home range estimates from data on fishers in Montana, Idaho (Jones 1991) and Maine (Arthur et al. 1989) using adaptive kernel analysis. Idaho home range estimates remained much higher than estimates in Maine and Montana, and Montana estimates were more similar to Maine estimates. Because of the possible influence of translocation and colonization in the Montana reintroduction study, the Idaho population may more closely reflect typical space requirements for fishers in the Rocky Mountains (Heinemeyer 1993).

<u>Seasonal home ranges</u>. Females have shown temporal stability in home range size in most studies (Kelly 1977, Arthur 1987, Arthur et al. 1989, Heinemeyer 1993). Solitary females must raise young themselves, and so should occupy a range which ensures adequate resources for reproduction. Because defense of a territory is easier than expansion (Stamps and Tollestrup 1984, Stamps et al. 1987, 1990), females should occupy temporally stable ranges which provide adequate food during the most critical periods (Sandell 1989).

Alternatively, females are the limiting resource to males in a solitary social system, therefore male distribution will be at least partly determined by the distribution of the females and intraspecific competition, at least during the breeding season (Sandell 1989, Lott 1991, Powell 1991). Adult male fishers typically increase movements and temporarily abandon home ranges to search for females during the breeding season (de Vos 1952, Coulter 1966, Kelly 1977, Buck and Mossman 1979, Johnson 1984, Jones 1991).

Few studies have examined seasonal changes in home range size of fishers outside the denning or breeding season. Kelly (1977) and Johnson (1982) did not find differences among monthly or seasonal home ranges. Home ranges in New Hampshire decreased in size from July through September, possibly due to increased food abundance and temperatures (Kelly 1977). Kelly (1977) reported that in January and February, fishers had home ranges slightly below average in size, and Johnson (1982) reported January home ranges were smaller, possibly due to "severe weather conditions". Fishers reintroduced into Montana maintained the smallest average home ranges during the winter (Heinemeyer 1993).

Movements and Activity

Fishers are active both day and night (Grinnell et al. 1937, deVos 1952, Hamilton and Cook 1955, Powell 1977, Johnson 1984, Roy 1991, Heinemeyer 1993). Powell reported 1 to 3 activity periods per day, with each activity period lasting 2 to 5 hours. Activity may increase during crepuscular hours (Kelly 1977, Johnson 1984, Arthur and Krohn 1991). Arthur and Krohn (1991) reported that a female with kits concentrated activity during the daylight hours, but Paragi (1990) found that individual females varied greatly in their circadian patterns and level of activity during all phases of the denning cycle.

Table 3. Annual home range sizes of male and female fishers determined using radiotelemetry.

Location	Sex	N	Average ± sd (km^2)	Range	No. Locations	Duration (Days)	Analysis[a]	Source
New Hampshire	M	6	22.7± 15.6		7-148	14-310	MA	Kelly 1977
	F	5	15.1± 0.50		7-148	14-310	MA	Kelly 1977
Manitoba	F	2	17.7	15.0, 20.5	25, 45	120	MA	Raine 1981
California	M	5	15.0	12.4-22.0	7-84	103-475	MA	Buck 1982
	F	5	8.0	3.3-13.8	10-23	87-127	MA	Buck 1982
	M	5	17.2± 12.7	5.9-34.1	6-58	60-425	MA	Mullis 1985
	F	3	2.7± 1.1	1.5-4.2	4-26	41-158	MA	Mullis 1985
Wisconsin	M	4	39.1± 26.4	15.2-75.2	68-79	25-237	MA	Johnson 1984
	F	8	7.5± 4.1	1.9-14.3	11-193	25-237	MA	Johnson 1984
Maine	M	7	30.9± 24.6	10.6-78.2	50[b]	215	HM	Arthur et al. 1989
	F	6	16.3± 11.4	8.1-39.1	50[b]	215	HM	Arthur et al. 1989
	F	6	11.1	8.2-31.6			AK[c]	Heinemeyer 1993
Idaho	M	6	82.6	28.8-119.5	15-64	210-700	HM	Jones 1991
	F	4	40.8	6.0-75.4	22-50	165-645	HM	Jones 1991
	F	4	25.2	5.1-41.0			AK[c]	Heinemeyer 1993
Montana	M	2	85.2	65.1-105.3	30, 64	191-263	AK	Heinemeyer 1993
	F	7	17.3	9.7-75.3	64-101	177-386	AK	Heinemeyer 1993

a MA refers to methods which use minimum area techniques for home range estimation
HM refers to harmonic mean analysis of home range
AK refers to adaptive kernel analysis of home range

b 50 independent locations selected from totals of 52-623

c Data used for adaptive kernel analysis provided by Arthur et al (1989) and Jones (1991)

Marten, mink, and weasels may alter their diel activity pattern to better coincide with their prey activity (Zielinski 1986, Zielinski et al. 1983). Although strict diel cycles have not been reported, fishers may opportunistically adjust their activity to changing resources or environmental conditions. Fishers reintroduced to Montana shifted activity to night and early morning hours during the winter, and Heinemeyer (1993) hypothesized that the animals may have timed activity to correspond to peak prey activity periods or periods when snow crust formed and allowed easier mobility. Diel cycles were not seen during other seasons, when both environmental and food constraints may have been less stressful (Heinemeyer 1993).

Inactivity after large meals (Coulter 1966) or during periods of extreme cold or severe storms have been noted (deVos 1952, Coulter 1966, Powell 1982). Fisher activity and movements may also be strongly influenced by soft snow and snow crust conditions (Leonard 1980, Johnson 1984, Raine 1983). Fisher movements in Wisconsin were restricted by soft snow depths greater than 46 cm (Johnson 1982), and Leonard (1980) estimated that fishers expend 54% more energy when traveling through soft snow as compared to snow with a hard crust. Both Leonard (1980) and Raine (1981) found that fishers altered their habitat use during the mid-winter to avoid areas with deep, soft snow. Fishers in Wisconsin (Johnson 1982) and in New Hampshire (Kelly 1977) had the lowest movement rates in January, and in January and February, respectively. Idaho fishers had shorter movements in the winter than in the summer (Jones 1991). Low movement rates and high activity levels of reintroduced fishers in northwest Montana during the winter may have been related to deep, soft snows, inefficient foraging in new habitats, or a combination of both (Heinemeyer 1993).

Movement distances. Fishers are capable of travelling relatively long distances over short time periods (Table 4). Males in particular make long distance movements during the breeding season when they temporarily abandon their home range to seek out estrous females (Leonard 1980, Buck 1982, Johnson 1984, Mullis 1985, Arthur et al. 1989, Jones 1991). deVos (1952) reported a fisher travelling 64 km in 3 days in Ontario. Jones (1991) reported fishers travelling 10 km in 2 days, and one fisher travelled 3 km in 2 hours. Johnson (1982) monitored movements in 1-hour time blocks; maximum distances travelled in 1 hour were 2.0 km for juvenile males, 1.6 km for adult males, and 0.8 km for adult females.

Animals dispersing from reintroduction sites are particularly prone to make long distance movements. From incidental captures and observations, fishers moved an average of 43.7 km (maximum of 90 km) from release sites in West Virginia (Pack and Cromer 1981). Movements up to 98 km were documented in Wisconsin (Olsen 1966), while a captive female made successive movements of 136 and 163 km from its release site in New York (Brown and Parsons 1983). In Montana, ear-tagged males and females were recovered up to 102 and 56 km from release sites (Weckwerth and Wright 1966). In a more recent reintroduction effort in Montana, Roy (1991) documented males and females moving up to 71 and 163 km from release sites, and a female fisher travelled over 30 km in 2 days.

Dispersal Behavior. Little information if available on dispersal distances and behavior of juvenile fishers. Juveniles generally disperse during the fall or early winter. In Maine, juveniles commonly dispersed 6 - 9 miles from the mother's range (Paragi 1990). Two 1-year-old male fishers in Idaho, dispersed 16 and 24 miles prior to settlement (Jones 1991).

Habitat Use

Landscape. Descriptions and quantitative studies of the habitat use of fisher are biased to

Table 4. Maximum reported distances travelled by fishers .

Distance moved (km)	Time	Location	Type	Source
64	3 days	Ontario	snow tracking	deVos 1951
10	2 days	Idaho	radio telemetry	Jones 1991
1.2 (M) 0.8 (F)	1 hour	Wisconsin	radio telemetry	Johnson 1982
64-104 (6 M)[a]		Wisconsin	eartag recovery	Irvine et al. 1964
80-96[1]		Wisconsin/ Michigan	eartag recovery	Olson 1966
42-90[1]	years	West Virginia	eartag recovery	Pack and Cromer 1981
55-56 (F)[a] 72-102 (2 M)[a]		Montana	eartag recovery	Weckwerth and Wright 1968
40[b]	8-9 years	Nova Scotia	eartag recovery	Irvine et al 1964
136-163 (2 M)[a,b]	10-11 months	New York	eartag recovery	Brown and Parsons 1983
71-163 (1M, 1F)[a]	4-6 months	Montana	radio telemetry	Roy 1991

[a] distances moved by transplanted fishers in reintroduction projects.
[b] previously captive males

habitats in eastern North America. Banci (1989) concluded that generally, habitats used by fishers have a high degree of diversity and interspersion. One of the consequences of having relatively large home ranges is the availability of diverse habitats. Similarly, because of the diversity in the fisher's diet, optimal habitat most likely includes a mixture of forest habitats (Arthur et al. 1989).

In the north coast region of California, 48% of 108 observations were in Douglas-fir habitats and 38% were in mixed conifer (Schempf and White 1977). Observations of fishers were rare in the south Sierra, where habitats were predominantly mixed conifer, and in the north Sierra, which consisted of mixed conifers at high elevations. In northern California, optimum habitat was reported to be comprised of 60-80% mature coniferous forests, 20-30% young forests (mixed conifer/hardwood), and 2-5% pole-sapling forests (small conifer) (Buck et al. 1983). Based on literature review, Freel (1991) characterized preferred fisher habitat in California as dense (60-100% canopy) multi-storied, multi-species, late seral stage, coniferous forests with a high number of large (>30 inch dbh) snags and downed logs, and an interspersion of small (<2 acres) clearings with good ground cover which would be used for foraging. The habitat should be located in close proximity to riparian corridors, saddles between major drainages, or other landscape linkages which could be used for movement and dispersal. In an ongoing radio telemetry study in northern California, Self and Kerns (in prep) reported that fishers use a wide variety of habitats including revegetated clearcuts and young second growth.

In Washington, records indicate that fishers inhabit a variety of densely forested habitats at low to mid-elevations (Aubry and Houston 1992). Records were located at lower elevations on the west side of the Cascade crest as compared to the east side, and snow depth and duration may limit fisher distribution on the west side. Of 55 records west of the Cascade crest, 87% were at elevations below 1000 m, and none occurred above 1800 m. Of the 46 records on the west side which could be assigned to a habitat type, the majority (54%) were from the western hemlock zone. Alternatively, on the east side of the crest, only 30% of the records occurred below 1000 m, and 18% were found at elevations between 1800-2200 m. The majority (53%) of the east side records were from the subalpine fir zone.

A diversity of habitat types and successional stages was evident in fisher home ranges in northcentral Idaho (Cooper et al. 1987, Jones 1991). The majority of observations of Idaho fishers occurred in mesic grand fir habitat types, while more xeric grand fir habitat types and subalpine, ponderosa pine and Douglas-fir habitats were avoided (Jones 1991).

Reintroduced fishers in northwestern Montana preferred mixed conifer and cedar/hemlock stands, and avoided subalpine fir and hardwood (usually alder and recent clearcut) habitats (Roy 1991). As the fishers colonized the area and established permanent home ranges, they preferred low elevation, flat or gently sloping, north-facing areas near (within 200 m) water (Heinemeyer 1993). The established fishers used predominantly mesic forested habitats, consisting primarily of mixed stands of grand fir, western red cedar, and western hemlock in the reintroduction area.

Edges were used extensively by fishers in New Hampshire (Kelly 1987), Wisconsin (Johnson 1984), Ontario (Clem 1977), and Manitoba (Leonard 1980). In New Hampshire, fishers were shown to prefer edge habitats in the summer, defined as the ecotone within 100 ft of a forest type change (Kelly 1977). In Manitoba, Leonard (1980) reported that fishers frequently selected ecotones between homogeneous forest stands. The highest trapping success in Wisconsin was within ecotone areas formed by small natural or manmade openings or habitat changes (Heinemeyer 1993). Fishers in Idaho and Montana were commonly located in forest stands adjacent to natural openings (Jones 1991, Heinemeyer, unpubl. data). Fishers may use edge habitats or ecotones because these habitats support a diverse prey base (Johnson 1984).

Rosenberg and Raphael (1986) believed that fishers in California were sensitive to forest fragmentation. Their study indicated that fishers were "area-sensitive"; fisher occurrence was correlated with stand size, and frequency of fisher occurrence decreased sharply in stands <250 acres. They also reported that frequency of occurrence decreased abruptly when ≥50% of a forest stand adjoined a clearcut. Most studies which have found fishers using edge habitats have been in eastern habitats, where vegetative productivity is high. In these habitats, natural and manmade-made ecotone areas are wide belts of complex habitats with many vegetative layers, often structurally similar to riparian areas. Alternatively, in western habitats, manmade ecotones, such as adjacent to a forest clearcut, are often abrupt changes in habitat type and structure. Although fishers in Montana were commonly located in ecotone areas adjacent to small, natural openings or waterways where the vegetation was structurally complex, they were rarely located in the abrupt edge habitats adjacent to forest clearcuts (Heinemeyer, unpubl data).

Fishers commonly use forested riparian areas along streams when moving across the landscape (deVos 1951, Buck 1982, Buck et al. 1983, Mullis 1985, Jones 1991, Heinemeyer 1993, Weir, in prep.). The importance of riparian and wetland associated areas was documented by Seton (1926) and has been confirmed for fishers in New Hampshire (Kelly 1977), Manitoba (Leonard 1980, Raine 1981), Wisconsin (Johnson 1984), Idaho (Jones 1991), Montana (Heinemeyer 1993) and British Columbia (Weir, in prep.). Fisher movement may also be concentrated along lakeshores and ridges (deVos 1951). Jones (1991) suggested that preferred resting habitat and prey are likely more available within forested riparian areas. Consequently, fishers would be less likely to

encounter unsuitable or suboptimal habitats when travelling along streams relative to routes along ridges or midslopes.

<u>Macrohabitat.</u> Grand fir habitat types dominated areas used by the fishers in Idaho, although the distribution of types among home ranges of individual animals was variable: grand fir/western goldthread and grand fir/queen cup bead lily ranged from 29-53% (mean = 42%), grand fir/twinflower 4-42% (mean = 22), grand fir arrowleaf groundsel 3-18% (mean = 11%), subalpine fir/twisted stalk and subalpine fir and bluejoint 0-13% (mean = 8), subalpine fir/bear grass 0-22% (mean = 10%), and ponderosa pine and Douglas fir habitat types 0-37% (mean = 8%) (Jones, unpubl. data). Similarly, the composition of successional stages within home ranges of individuals was also variable: mature and older-forests ranged from 22-74% (mean = 53%), young forests 0-39% (mean = 27%), and pole-sapling and younger forests (including natural openings 0-47% (mean = 21%) (Jones, unpubl. data)..

Grand fir and Engelmann spruce dominated stands used by the Idaho fishers in the summer and accounted for approximately 73% of the mean total basal area, whereas in winter, grand fir, Engelmann spruce, and lodgepole pine dominated stands. Fishers selected summer habitat in Idaho having a relatively high composition of moderate to large diameter spruce (≥20 cm dbh), large diameter Douglas-fir (>46 cm dbh, and small diameter Pacific yew (13-20 cm dbh), whereas they avoided stands that had a large lodgepole pine or ponderosa pine component. In winter, fishers selected stands having relatively high basal areas of Douglas-fir and lodgepole pine (Jones 1991).

Mature and old-growth coniferous forests have commonly been described as optimal or preferred fisher habitat (deVos 1951, Coulter 1966, Ingram 1973, Kelly 1977, Schempf and White 1977, Buck 1982, Allen 1983, Raphael 1984, Mullis 1985, Rosenberg and Raphael 1986). In Idaho, there was a seasonal shift in the use of successional stages (Jones and Garton 1994). During summer, 90% of all fisher use observations occurred in mature and old-growth forests, and these age-classes were preferred. During winter, 54% of animal relocations occurred in mature and old-growth forests, and 46% occurred in young forests. Although old-growth forests were preferred, young forests were the most preferred successional stage in winter (Jones and Garton 1994). Roy (1991) also found fishers reintroduced in Montana preferring dense stands of young to moderately aged mixed-conifer and cedar-hemlock forest types. In Maine, productive fisher habitat consisted of predominantly second-growth forests (Arthur 1987).

A broader range of habitats may be used for hunting than for resting (Jones 1991). In Idaho, resting animals preferred mature forests, avoided younger ages, and showed no preference for old-growth in the summer (Jones and Garton 1994). Summer use of mature and old-growth forests was greater for resting activities (92%), while hunting occurred in broader range of successional stages (Jones and Garton 1994). Arthur et al. (1989) reported that active fishers used a wider variety of forest types than resting animals in Maine.

In general, fishers are believed to prefer forests with continuous canopy closure (Powell 1982, Johnson 1984) and avoid openings (deVos 1952, Coulter 1966, Kelly 1977, Buck 1982, Johnson 1984, Mullis 1985, Roy 1991, Jones 1991). Fishers in New Hampshire selectively used forested habitats having ≥80% canopy cover, whereas they avoided stands having <80% canopy cover, particularly stands having <50% canopy cover (Kelly 1977). In California, preferred stands having canopy coverage exceeding 40% (Buck 1982). In Idaho, fishers preferred stands with canopy cover ≥61% for resting, and stands with canopy cover >80% for hunting.

The avoidance of openings may be somewhat dependent on season of the year and vegetation type, with clearing used if sufficient cover is provided by a shrub canopy. Clearcuts having dense evergreen shrub cover may be important to fishers for foraging during winter (Buck 1983, Mullis 1985). Fisher in New Hampshire avoided clearcuts in the winter, but not in the summer when deciduous species may have provided sufficient

cover. Similarly, Johnson (1984) reported that fishers used some habitats more frequently during summer when deciduous leaves provided concealment. In an ongoing radio-telemetry study in California, fishers are reported to use a wide variety of habitats, including revegetated clearcuts and young second growth (Self and Kerns, in prep).

Forested stands containing, or located immediately adjacent to riparian areas are particularly important to fishers. Fishers strongly selected wetland forest types in New Hampshire (Kelly 1977), Michigan (Powell 1982), California (Buck 1982, Mullis 1985), Idaho (Jones 1991), and Montana (Heinemeyer 1993). In Idaho, selection for forested riparian areas was evident at several scales of habitat selection in winter and summer. In summer, 50% and 75% of the fisher observations were within 15 and 23 m of water, respectively (Jones 1991). In Montana, fishers preferred areas with within 200 m of water (Heinemeyer 1993). Riparian habitats are also used extensively as travel corridors (deVos 1951, Buck 1982, Mullis 1985, Jones 1991, Heinemeyer 1993).

Dispersal Habitat. Potential barriers to dispersal include large rivers (Kelly 1977, Roy 1991, Jones 1990), mountain divides above timberline (Heinemeyer 1993), and open-canopied habitats (Jones 1990). Long strips of unsuitable habitats may effectively block fisher movements if corridors of suitable habitat are not present. Riparian corridors may provide critical dispersal habitats (deVos 1985, Buck 1982, Buck et al. 1983, Mullis 1985 Jones 1991, Heinemeyer 1993). Buck et al. (1983) suggested that timbered saddles between major drainages may serve as important landscape linkages for fishers.

Resting Sites. Fishers appear to be opportunistic in their use of resting sites. Hollow logs (Seton 1926, deVos 1952, Bradle 1957, Kebbe 1961, Coulter 1966, Powell 1977, 1982; Jones 1991), tree cavities (Kebbe 1961, Ingram 1973, Powell 1977, 1982; Arthur 1987), and rocks (Seton 1926, deVos 1952, Kebbe 1961, Ingram 1973, Powell 1977, 1982; Raine 1981) appear to be the most frequently reported resting sites used by fishers. The use of ground burrows (Coulter 1966, Powell 1977, 1982; Arthur 1987), and fallen trees and brush piles (deVos 1952, Coulter 1966, Raine 1981, Johnson 1984, Jones 1991) as resting sites have also been frequently documented.

Resting sites within the canopy of live trees were used most often during summer and winter in Maine (Arthur et al. 1989), Wisconsin (Kohn et al, in press), Idaho (Jones 1991), and California (Buck et al. 1983). In Idaho, fishers most commonly rested in the canopies of live trees (77.9%), followed in importance by logs (14.5%), and snags (7.6%) (Jones 1991). Similarly in California, fishers utilized trees (65%), logs/slash (17%), snags (12%), and ground burrows (6%) (Buck et al. 1983). The average dbh of trees used for resting sites in Idaho was 56 cm (range=28-150 cm) (Jones 1991). Trees used as resting sites in California averaged 114 cm dbh (range = 51-163+ cm dbh) (Buck et al. 1983). The average diameter (small end) of logs used as resting sites in Idaho was 53 cm (range=41-76 cm) (Jones 1991).

Fishers commonly use witches brooms while resting in the canopy of live trees (Arthur et al. 1989, Jones 1991, Weir, in prep). Selection of tree species per se used for resting sites may not be as important as the canopy structure of a tree or its location. For example, in Idaho, tree resting sites were most commonly located in Engelmann spruce (63%) and witches brooms also seemed to be most prevalent in Engelmann spruce (Jones 1991). Furthermore, Engelmann spruce was generally located within forested riparian areas in the Idaho study area. In all likelihood, fishers probably selected forested riparian zones first, then searched the available trees for suitable resting substrates. Thus, any tree species having witches brooms could potentially be used for a resting site.

Selection of resting sites may be partially a function of ambient temperature. Use of ground burrows in Maine (Arthur et al. 1989) and hollow logs in Idaho (Jones 1991) increased during winter. Arthur (1986) reported that fishers usually rested in ground burrows when the minimum temperatures consistently dropped below 0° C, especially when snow was present. It appears that the use of resting sites on the ground (i.e.,

burrows, logs, and subnivean sites) may have important implications for thermoregulatory requirements during periods of cold stress. Buskirk et al. (1989) found the selection by marten of subnivean cavities with coarse woody debris to have important thermoregulatory implications. These cavities have microclimate temperatures ranging from -5.0° to -2.5° C, while the above-snow ambient temperatures ranged from -28° to 9° C.

Natal Dens. Cavities in either live or dead trees are the most commonly reported sites for natal dens (Seton 1926, Grinnell et al. 1937, Hamilton and Cook 1955, Hamilton 1957, Ingram 1973, Kelly 1977, Powell 1977, 1982; Leonard 1980, Raine 1981, Mullis 1985, Arthur 1987, Paragi 1990). In British Columbia, whelping occurred exclusively in large diameter (>90 cm dbh) declining black cottonwoods (Weir, in prep). The one natal den discovered in California occurred in a 89 cm. dbh pine snag (Buck et al. 1983). Hollow logs (Grinnell et al. 1937, Roy 1991) and rock substrates (Grinnell et al. 1937) may also be used as natal dens. Most natal dens occur in deciduous trees, possibly because cavities are more prevalent in deciduous trees than in conifers. With the exceptions of cottonwood and aspen, there are virtually no deciduous species of suitable size, and which occur within suitable fisher habitats, to serve as potential den sites. Consequently, in the absence of hardwoods, hollow logs may be more important as natal dens sites in western North America than in central or eastern North America where deciduous species are relatively common.

Use of multiple natal dens during the whelping period has been reported in Manitoba (Leonard 1980) and Maine (Paragi 1990). As kits grow and develop, the female may move them as many as 5 different times during the denning period; In Maine, the median distance between successive den sites was approximately 576 m (range 150-2650 m; Paragi 1990). Consequently, potential den sites should be widely distributed across the landscape to maintain optimum fisher habitat.

Disturbance. In New Hampshire, the presence of human activity and domestic animals appeared to have little effect on fisher movements (Kelly 1977). Arthur et al. (1989) reported that fishers in Maine tolerated a marked degree of human activity, including low density housing, farms, roads, gravel pits, and small-scale logging operations. Similarly, Kelly (1977), Jones (1991) and Heinemeyer (unpubl. data) commonly observed animals in close proximity (70-460 m) to occupied residencies. Fishers in Idaho were frequently observed feeding on foods placed on window ledges of occupied dwellings for birds and squirrels (Jones 1991). Additionally, Idaho fishers were rarely flushed from their rest sites even though field researchers commonly spent as much as 1 hour within a few meters of the animal (Jones, unpubl data).

Females with kits may be more sensitive to human disturbance. In Maine, monitoring activity may have resulted in increased number of dens (4-5 dens per female) used by 5 females (Paragi 1990). Lactating females live-trapped in Maine did not return to a natal den, and possibly abandoned the kits after the trapping incident (Arthur and Krohn 1991).

Indirectly, human activities may lead to negative impacts on fishers through removal or development of high quality habitat, fragmentation and isolation of habitats, and increased human access to fisher populations. Although most roads may not impede fisher movements, the increased accessibility to trappers may result in increased fisher mortality through direct or incidental trapping.

Population Reestablishment and Reintroduction

The regulation of trapping and several reintroduction efforts were instrumental in the re-establishment of fishers in several states and Canadian provinces. Fisher trapping seasons were closed in most states by the 1930s (Brander and Books 1973). This protection, as well as the end of the logging boom in the east and midwest, enabled some

remnant fisher populations to recover and expand. A population within a wildlife refuge was important for the reestablishment of fishers in Ontario (deVos 1951). Although the primary population source was from the refuge, residual pockets of fishers outside the refuge may have enhanced the rate of colonization by providing stepping stone populations (deVos 1951). Habitats initially colonized were comprised of a greater percentage of mature forests, were closer to climax, and had a greater percentage in coniferous trees (deVos 1951).

Population increases and the re-colonization of habitats by fishers in Maine was documented by Coulter (1960). Protection from trapping and the presence of a reserve population were the most important factors responsible for the recovery (Coulter 1960). Trapping seasons were closed in 1937 and reopened in 1950, a reestablishment period of only 13 years. In the next 3 years, fishers expanded their range another 14,040 km^2, at a rate of 4680 km^2 per year. In the next 7 years, the fisher range of 20,800 km^2 expanded to 36,800 km^2, a rate of 2400 km^2 per year.

In several states and provinces, fisher populations recovered after protection from trapping, and some states were able to reopen fisher trapping seasons. New Hampshire and West Virginia allowed trapping of fishers starting in 1969, Massachusetts in 1972, Vermont in 1974, and Minnesota in 1977 (Douglas and Strickland 1987). Some populations declined under the trapping pressure. Maine closed the season again from 1951-1954, and limited the harvest in 1977; New Hampshire closed its season again in 1977 and New York had to limit its harvest that same year (Powell 1982).

Reintroductions. Nova Scotia attempted the first documented reintroduction of fishers, with the release of 92 animals in 1947-66 (Dodds and Martell 1971) (Table 5). The effort was successful, and beginning in 1977, limited trapping was allowed (van Nostrand 1977). Many states followed the example. Between 1956-1966, Wisconsin released 120 fishers and in 1961-1963, Michigan released 61 fishers. Both efforts were successful in reestablishing fisher populations (Irvine et al. 1964; Olson 1966, Kohn et al., in press). Idaho re-established a population with the release of 39 fishers in 1962-1963 (Dodge 1977), and Montana released 36 fishers in 1959-1960 with limited success (Weckwerth and Wright 1968). Montana undertook another reintroduction effect starting in 1988, transplanting 110 fishers from Minnesota and Wisconsin (Roy 1991, Heinemeyer 1993).

Reintroduction efforts were initiated in Wisconsin in 1956 (Krohn et al., in press). Over an 11-year period, a total of 60 fishers were released on the Nicolet National Forest (N. F.) and another 60 on the Chequamegon N. F. All dry-land trapping was prohibited in areas surrounding the release sites. These areas, totaling 120,000 acres on the Nicolet N. F. and 220,000 acres on the Chequamegon N. F., are maintained as "Fisher Management Units" to provide refugia for the reintroduced populations of fishers and recently reintroduced American marten. The fisher reintroductions in Wisconsin were successful and rapid expansion of the fisher distribution was documented (Kohn et al., in press). By 1975, fishers occupied a quarter of their former range, and by 1981 were reported to be in all of the northern forests of Wisconsin though "common" in only a third of this area. The fisher stabilized by 1981, but densities continued to increase. By 1988, fishers were well established throughout most of the suitable habitat in Wisconsin, reaching densities up to 0.1/ km^2. The recovery of the fisher in Wisconsin took only 20-30 years (Kohn et al., in press).

The reintroduction in northwestern Montana consisted of 4 releases over 4 years (1988-1991), for a total of 110 fishers. In the first 2 years, 32 fishers were translocated from Minnesota (Roy 1991), and in the final 2 years 78 fishers were translocated from Wisconsin (Heinemeyer 1993). Radio-telemetry was used to monitor the movements and activity of the fishers. During the first 4-6 months, the fishers had a high mortality rate and

Table 5. Known fisher reintroduction attempts

Location	From	Total No. Known M,F	Date	Comments	Source
Oregon	British Columbia	24 10,14	1960	limited success	Kebbe 1961, Moarse 1961
Wisconsin/ Michigan	New York (12) Minnesota (103)	121 78,43	1956-63	successful	Irvine et al. 1964
Wisconsin	Minnesota	60 30,30	1966-67	successful	Petersen et al 1977
New Brunswick (southern)	New Brunswick (northern)	25 10,15	1966-68	no reproduction	Dilworth 1977 <u>in</u> Berg 1982
West Virginia	New Hampshire	23 6,10	1968	limited success	Pack and Cromer 1981
Nova Scotia	Maine (80) ranch (12)	92 31,57	1947-48, 1963-66	7 sites, successful	Benson 1959, Dodds and Martell 1971
Idaho	British Columbia	11 5,6	1962	successful	Williams 1962
New York (Catskills)	northern New York	43 unknown	1977	successful	Brown and Parsons 1983, Wallace and Henry 1985
Montana	British Columbia	36 16,20	1959-60	moderate success	Weckwerth and Wright 1968
Minnesota (northwest)	Minnesota (southwest)	15 unknown	1968	no evaluation	W. Marshall <u>in</u> Berg 1982
Ontario (northern)	Ontario (Algonquin Park)	25	1956	no evaluation	C. Douglas <u>in</u> Berg 1982
Ontario (Algonquin)	Ontario (Parry Sound)	97 37, 60	1956-63	successful	C. Douglas <u>in</u> Berg 1982

Table 5. Continued.

Location	From	Total No. Known M,F	Date	Comments	Source
Ontario	Bancroft Island	57 27, 30	1979-82	no evaluation	C. Douglas in Berg 1982
Vermont	Maine	124 19, 16	1959-67	successful	Fuller 1975 in Berg 1982
Maine (eastern)	Maine (western)	7	1972	failed	J. Hunt in Berg 1982
Oregon	Minnesota	13 8,5	1981	no evaluation	J Schneewies in Berg 1982
Montana	Minnesota (32) Wisconsin (78)	110	1989-92	too soon to evaluate	Roy 1991, Heinemeyer 1993

dispersal rate in all years, with most dispersal occurring in the spring (Roy 1991, Heinemeyer 1993). During this 4-6 month "acclimization period" the fishers exhibited random habitat use and high activity levels (Heinemeyer 1993). Following this period, mortality rates declined and a preference for mesic, low elevation habitats was evident (Heinemeyer 1993). Although fishers from the first release did not settle in the area (Roy 1991), subsequent releases saw increasing numbers of fishers establishing home ranges in the study area. At least three of 20 animals from the second release were known to establish home ranges in the area, while 7 of the 24 animals monitored from the third release settled in the study area (Heinemeyer 1993). Animals were not monitored from the final release. In British Columbia, fishers were translocated from within the Province established home ranges in 2 to 5 months (Weir, in prep.). The translocated fishers in B. C. did not experience initial high mortality as did the fishers translocated from the midwest to Montana.

POPULATION DYNAMICS

Population Composition

Little is known about the composition of fisher populations and the stability of spatial systems over time. Arthur and others (1987, Arthur et al. 1989) have monitored the largest number of individuals within a fisher population. He reported no transients in his study, however intensive trapping removed a large proportion of juveniles and continually created open home ranges (S. Arthur, in Banci 1989). Marten populations consist of transients, temporary residents, and permanent residents (Weckwerth and Hawley 1962, Thompson and Colgan 1987), with the structure of the populations changing through years, possibly due partially to resource availability (Weckwerth and Hawley 1962, Thompson and Colgan 1987). It is likely that fisher populations also have transient and temporary resident members.

Harvests

Sex and Age Ratios. Harvests reflect the vulnerability and abundance of sex and age classes and the effort expended by the trappers (Banci 1989). Males are more vulnerable to trapping because of their larger movements, particularly during the breeding season, and in lightly trapped populations, harvest should reflect this vulnerability with males dominating the harvest (Douglas and Strickland 1987, Banci 1989). Because males maintain larger home ranges than females, typical populations would be expected to have fewer males than females. As trapping pressure increases, the harvest should reflect this true population sex ratio (Banci 1989).

Because of their greater abundance and movements, juveniles typically comprise the largest segment of the harvest, ranging from 54% to 71% in Ontario (Douglas and Strickland 1987). In Maine, 10 of 17 radio-tagged juveniles (both sexes) were harvested (59%), whereas only 2 of 13 adult females were removed (Arthur 1987).

It is more common to find older females in the harvest than older males. In Minnesota, only one male was older than 4.5 years, while 11 females were older than 5.5 (Kuehn and Berg 1979). In Ontario, the percentage of females 3.5 to 10.5-years-old exceeded the percentage of males, for all age classes (Douglas and Strickland 1987).

Montana is the only western state to allow harvest of fishers. Since 1977, 95 fisher carcasses or skulls have been collected from trappers by Montana Department of Fish, Wildlife, and Parks, and examined by Aune and Schladweiler (1993). Sex ratios for northwestern and southwestern Montana populations was 42.3:57.7 and 57.1:42.9 (M:F), respectively, and the statewide sex ratio was 1:1. Juveniles comprised 40.4% of the

harvest. The mean age for all specimens was 2.3 (sd=2.53) with males and females having similar age distributions.

Density

Population densities estimated for regions in eastern North America range from 1 fisher/0.6 km^2 to 1/18.9 km^2. Arthur et al. (1989) estimated fisher densities in his study area in Maine to be 1/10 km^2. Densities estimated from trapping returns in Ontario and radio-collared fishers in Wisconsin were 1/6.5 km^2, and 1/19 km^2, respectively (Johnson 1984, Douglas and Strickland 1987). Though studies of fisher in the west has lagged behind the more eastern areas, preliminary estimates indicate that densities are lower. In California, densities were estimated at 1/206 km^2 by Grinnell et al. (1937), and trapping returns in British Columbia indicate a density of fisher of 1/208 km^2 (Quick 1953). Though B.C. has the largest expanse of apparently "suitable fisher habitat", the productivity of its habitats is reported as one of the lowest in Canada (Banci 1989). Because of intra-sexually exclusive home ranges, densities are a function of home range size. Jones (1991) hypothesized the large home ranges and resultant low density of fishers in Idaho were a result of the generally poorer habitats in western areas as compared to eastern habitats.

Population and Metapopulation Status in Western Habitats

In the western United States, the distribution of the fisher is confined to the peninsular mountain ranges of the Pacific Coast and the Rocky Mountains, forming the southern margins of a larger continental distribution. Many of the factors that may lead to extinction through time may be important in limiting a species at the margins of its geographic range (Weaver 1993). These factors include increased vulnerability to stochastic changes and reduced potential for immigration due to increased isolation of suitable habitats and populations (reviewed in Weaver 1993). Additionally, the mountainous habitats occupied by fishers in the western United States may increase the vulnerability of the species because of the greater environmental stochasticity inherent in these habitats (Weaver 1993) and the increased probability of habitat islands forming due to developed valley bottoms. Habitat fragmentation and habitat loss may be the most critical issues in this species' viability and conservation.

Fishers appear to selectively use specific habitats in western landscapes (Jones 1991, Heinemeyer 1993); it is likely that these quality habitats are patchily distributed in present landscapes. Furthermore, fisher populations are widely dispersed and probably exist in isolation from other populations. Even within a region, such as the northern Rockies, the present, widely-spaced populations may not exchange individuals. This isolation greatly increases the risk of extinction for individual populations and for the species in the region.

The effect of habitat fragmentation depends upon the size of the fragments and the spatial scale in which they are arranged in relation to the dispersal capabilities of the species (Doak et al. 1992, Johnson et al. 1992). If the habitat fragments are small and widely dispersed, successful immigration is predicted to be low. Similarly, Pulliam and Danielsen (1991) predicted more animals would settle in sink habitats if suitable habitats were highly dispersed across the landscape, reducing overall productivity of the regional population. Several researchers have emphasized the reliance of populations in patchy environments on the connectivity of the patches in relation to the species dispersal capabilities (Fahrig and Paloheimo 1988, Fahrig and Merriam 1985, Lefkovitch and Fahrig 1985, Noss 1991). Little is known of the dispersal and colonization capabilities of fishers, or the degree to which present populations are inter-related. The greatest longterm risk to the fisher in the

western United States is probably population extinction due to isolation of small populations.

Federal and State Status

The Pacific coast population of fisher is currently listed as a Category 2 species by the U.S. Fish and Wildlife Service (USFWS). These are taxa for which information now in possession of the USFWS indicates that proposing to list as endangered is possibly appropriate, but for which conclusive data on biological vulnerability and threat are not currently available. A petition to the USFWS to list the Pacific fisher as endangered in California, Oregon, and Washington was filed in 1990. Under the Endangered Species Act, the term "species" is defined to include "subspecies...and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C. 1532[16]). Controversy exists as to whether the Pacific fisher (Martes pennanti pacifica) is a distinct subspecies, as named by Rhoads (1898) because of a lack of distinguishing morphological characteristics. But the Service concluded that the Pacific fisher represented a distinct population, genetically separated from Rocky Mountain populations by dispersal barriers, as outlined in Chesser (1983) and Jones (1990).

The U.S.D.A. Forest Service lists the fisher as a sensitive species in all western regions within its distribution with the exception of Region 6 (Washington/Oregon), where the fisher is currently proposed for sensitive status. A Forest Service sensitive species is one for which population viability is a concern as evidenced by significant current or predicted downward trends in population numbers or density, or habitat quality.

In the western United States, the fisher is not harvested in California, Oregon, Washington, or Idaho. The fisher is considered a nongame species in California, but is classified as a furbearer in Idaho and Oregon, with closed trapping seasons. In California, Oregon, and Washington, the fisher has been classified as a state sensitive species or species of special concern. Montana is the only western state to currently allow harvest of fishers.

In British Columbia, the fisher is classified as a Class 2 furbearer: those species "not present on registered traplines in manageable numbers and which are vulnerable to overharvest" (Banci 1989, pp 51). Management of Class 2 species is at a larger scale than that of the registered trapline, and regional management strategies are required. Fisher populations in the province were believed to be in decline since 1983, a function of many factors including habitat loss, illegal use of poisons, and, in some cases, over-trapping. Despite closed trapping seasons in 1991 and 1992, incidental captures approached or exceeded legal harvests in previous years. However, population and carcass indices indicated increasing recruitment of young and that recovery had likely begun. The season was re-opened in 1993 with mandatory carcass submission (Banci, pers. comm.).

PART II: ADAPTIVE MANAGEMENT STRATEGY

"The fisher is one of the very wildest of all wild animals, and I believe that hardly another suffers so much from being caged. Of course, all of the hunters are rendered infinitely miserable and unhappy by being deprived of the freedom which is their life; but of all those I have seen imprisoned, not even the pine martens or lynxes looked at me with such hopeless despair as the fisher, and I earnestly hope that I may never have to see another in a cage." (Stone and Cram 1905).

INTRODUCTION

Fishers prefer late-successional forests in western habitats (Buck 1982, Mullis 1985, Rosenberg and Raphael 1986, Jones 1991). The availability of such forests have decreased over the last 50 years within the fishers' current and historic western distributions. The continuation of current forest management practices will likely result in further fragmentation of mature and older forests and increased isolation of smaller parcels of potential habitats within a matrix of unsuitable and/or unproductive habitats across the landscape.

Fisher populations are vulnerable to over-trapping (Powell 1979, 1982), especially in habitats where prey productivity is relatively low, and environments are relatively harsh (i.e., long, cold winters in association with deep snows). Even in areas where fishers are legally protected from trapping, incidental trapping mortality may limit population growth (Jones 1991, Roy 1991, Heinemeyer 1993). As forest management activities proceed, the landscape is increasingly fragmented by roads. Consequently, trapping access and efficiency is improved, and the proportion of the landscape and fisher populations relatively secure from trapping decreases.

Planning for the long-term viability of fishers will require both population and habitat management strategies. Moderate to high trapping pressure may cause local extinction of fisher populations regardless of the existence of a thoroughly designed and well-implemented habitat management scheme. The historical record of the fishers' decline suggests that fishers were extirpated from much of their historic western range before humans had a pronounced influence upon the composition and structure of the western landscape. Historically, exploitation may have been the primary cause for the decline of fishers throughout their range.

We presently lack much of the required information necessary to develop an in-depth conservation strategy for fishers across western North America. Moreover, it may be cost-prohibitive to acquire the needed information across the fishers' historic and present range. The habitat needs of fishers may best be addressed by adopting a coarse-filter or ecological approach across a hierarchy of ecological landscape units (Hunter 1991). This approach addresses concerns at several scales, from maintenance of genetic linkages between metapopulations to management of resting or foraging habitats at the stand level (Table 6).

The following guidelines are meant to provide interim direction for fisher management, and should be modified and updated as new information becomes available. Particularly critical to successful management of fishers across western North America will be the completion of: 1) regional and site-specific inventories; 2) site-specific strategies for each hierarchical level; 3) habitat maps at each

Table 6. Example of a hierarchical approach of management.

ELU[1]	Scale	Landscape Strata	Habitat Resolution	Vegetation Map/Data	Population Attribute
Continental	1:10MM	Rocky Mtns	Coniferous forest	Kuchler (1964) Bailey (1976)	Geographic populations (Pacific/B.C)
Physiographic Region	1:1MM	N. Rockies Coast Range Sierras Cascades	Temperate mesic forests	Kuchler (1964) Bailey (1964)	Metapopulations
Physiographic Area	1:500,000 - 1:250,000	N.N. Rockies Pioneer Mtns	Cover type	GAP (Scott et al. 1991)	Individual metapopulations Subpopulation
Major Watershed	1:100,000	Wise River	Series	GAP (Scott et al. 1991)	Home ranges
Subdrainage	1:24,000	Lacy Creek	Association/ Habitat type	Local habitat map (e.g., TSMRS)	Individual home range
Stand	1:15,000		Habitat type phase	Local habitat map (e.g., TSMRS)	Within a home range

[1] ELU=Ecological Landscape Unit

hierarchical level; and 4) a metapopulation model and multiple simulations to test the hypotheses/recommendations concerning viability.

Ideally, an ecosystem approach, which would maintain structure, function, and processes across a variety of landscape scales, is preferred over single-species management. The implementation of an ecosystem approach requires some understanding of the range of natural variability of numerous landscape attributes across several scales. Reaching this level of knowledge may take several years, during which management of individual species may be required to ensure population viability. The following guidelines will assist in maintaining management options necessary to ensure the viability of fishers across the western landscape.

The proper use of the guidelines involves an iterative process, with assumptions and hypotheses made at one hierarchical level validated and tested at the next lower level. As the scales become finer, requiring increased resolution of information, the assumptions made at higher levels may need to be revisited. The guidelines are referred to as adaptive to emphasize the need to test and modify recommendations at all scales as more information becomes available.

The overall goal of this management strategy is to maintain fisher populations with high persistence probabilities across their historic range throughout western North America. This goal may be achieved through meeting the following objectives:

1. Manage for the continued distribution of fishers throughout their current range.

2. Manage habitats so that subpopulations of fishers have the opportunity to interact demographically, thereby minimizing the risks to long-term viability to the metapopulation.

3. Manage for the restoration of habitats and populations within the fishers' historic range.

4. Monitor and conduct research to evaluate whether the goals and objectives are being met and to facilitate adaptive management.

MANAGEMENT STRATEGY

The following outlines an adaptive management strategy using a hierarchical approach of ecological landscape units. Within each hierarchical level are overall goals, specific objectives, methods, guidelines, and possibly preliminary results. Organization is from the largest to the smallest landscape unit (Table 6).

Continental

The management goal at this scale is to demographically and genetically link the peninsular Pacific and Rocky Mountain populations to the Canadian population.

A. OBJECTIVES

1. Determination and recovery of historic population status in southern B.C. and the northern regions of the Rocky Mountains and Cascades in the U.S. is required. It has been suggested that viable populations of fishers did not occur historically in southern B.C., and that this region

may have functioned only as a linkage or corridor (V. Banci, pers. comm.).

2. Provide for the natural dispersal from the central portion of the fishers' range (in Canada) to the peninsular range in Rocky Mountains and Cascades. Allow for the exchange of at least one individual per generation (i.e., 2 yrs) to maintain genetic diversity (Allendorf 1983). Joint responsibility among B.C. and Alberta, Canada; Washington, Idaho, and Montana (state agencies and U.S. Forest Service).

B. Methods

1. Map potential habitat
   a. Map: Bailey's (1976) Ecoregions of the United States
   b. Scale = 1:7,500,000
   c. Potential Habitats:

      1) Columbia Forest Province
         a. Douglas-fir Forest
         b. Cedar-Hemlock-Douglas-fir

      2) Pacific Forest Province
         a. Sitka Spruce-Cedar-Hemlock
         b. Redwood Forest
         c. Cedar-Hemlock-Douglas-fir Forest
         d. California Mixed Evergreen Forest
         e. Silver Fir-Douglas-fir Forest

      3) Sierran Forest Province

      4) Rocky Mountain Province
         a. Grand Fir-Douglas-fir Forest
         b. Douglas-fir Forest

2. Map current and historic fisher distribution

C. Preliminary Results

Maps of potential habitats and historic fisher distribution suggest that one contiguous fisher population extended across western North America. Canada contains the "core" population, whereas peninsular populations extend southward along the Coast, Cascade, and Rocky Mountain Ranges. For all practical purposes, the Pacific and Rocky Mountain populations may have been (and still are) genetically isolated by geographic distance, and probably by physical and ecological distances (see Chesser 1983 for definitions). Presently, the two populations are undoubtedly genetically and demographically distinct since fishers have been extirpated in southern British Columbia.

Physiographic Region

The management goals at this scale are to maintain or recover the fisher throughout its historic range, and to maintain or recover the suitability of potential

habitat. This is at a metapopulation level, and should be implemented across such landscape units as the Northern Rocky Mountains, the Coast Range, the Cascades or the Sierra Nevadas

A. Objectives

1. Maintain existing genetic diversity by preserving the genetic linkages between metapopulations. Minimize human-induced barriers to dispersal in sensitive-linkage zones. This includes potential mortality factors (i.e., trapping), as well as habitat-alteration activities.

2. Conduct genetic studies to establish the variability within and among identified metapopulations, and determine the effect of past reintroductions on genetic variability.

3. Identify and prioritize potential recolonization or augmentation areas. Use a "stepping-stone" approach to expand populations out from existing occupied habitats or to link distant subpopulations.

4. Maintain the potential for dispersers to move across sensitive-linkage zones. Manage indirect mortality/vulnerability factors to allow for the successful dispersal of at least one individual every 2 years to maintain genetic diversity. In areas that are trapped for any terrestrial furbearer, limit road densities (accessible to trappers) to 0.2 km/km^2 (0.3 mi/mi^2) or less. This would approximate one open road bisecting the entire length of an average size male homerange in Idaho. An alternative to open road management would be to restrict furbearer trapping within the linkage zone, at least during the dispersal period (i.e., October through March).

5. Prevent (or mitigate for) the creation of induced ecological barriers. Clearings (i.e., $\leq$30% canopy cover) greater than 500 ft wide should not bisect sensitive-linkage zones. If clearings must bisect a sensitive zone, then mitigate by managing a stepping-stone "bridge" of cover patches consisting of trees $\geq$ 5 m tall. Cover patches should be at least 0.2 ha in size and be within 30 m of each other. These habitat "bridges" should be established at a frequency of at least one per mile.

B. Methods

1. Delineate potential habitat.

   a. Map: Kuchler's (1964) "Potential Natural Vegetation of the Conterminous United States."

   b. Scale = 1:3,168,000

   c. Potential Habitat

      1) Needleleaf Forests

         a. Spruce-cedar hemlock
         b. Cedar-hemlock-Douglas-fir
         c. Silver fir-Douglas-fir
         d. Fir-hemlock
         e. Mixed conifer
         f. Redwood

g. Red fir.
h. Lodgepole pine-subalpine
i. Douglas-fir
j. Cedar-hemlock-pine
k. Grand fir-Douglas-fir
l. Western spruce-fir

2) Broadleaf Forests
   a. Alder-ash
3) Broadleaf and Needleleaf Forests
   a. California mixed evergreen

2. Delineate metapopulations by identifying physical (e.g., major rivers) and ecological (e.g., unsuitable habitat) barriers.
3. Identify "sensitive" linkage zones necessary to prevent the further fragmentation of populations.
4. Delineate the historic and current distribution of fishers throughout western North America.
5. Inventory to identify occupied and vacant habitats.

D. Preliminary Results

Physical barriers identified include large water bodies, greater than 460 m (500 ft) wide, that remain unfrozen throughout the winter (e.g., the Columbia and Snake Rivers). Managers familiar with local areas will be able to identify potential barriers within each region. Using the Columbian and Snake Rivers as two physical barriers, in conjunction with ecological barriers identified on the habitat map, 7 potential metapopulations in the western United States were identified (habitat maps of Canada were not available to conduct a similar exercise) (Figure 1). Twelve sensitive-linkage zones were also identified at this scale.

1. Pacific Metapopulations
   a. Western Washington
   b. Southern Pacific (includes western Oregon and the California populations)
   c. Northeast Oregon (includes the Blue Mountains of Oregon and Washington)

2. Rocky Mountain Metapopulations
   a. North Idaho (includes northeast Washington, extreme northwest Montana, as well as the Bitterroot and Sapphire Mountains in Montana)
   b. South Idaho (includes all of Idaho south of the Salmon River)
   c. Northern Continental Divide (includes portions of the Helena and Deerlodge National Forests)
   e. Yellowstone National Park and surrounding region

3. Sensitive Linkage Zones
   a. Sierran/Cascade Interface (in Shasta/Trinity area of California).
   b. Bonner's Ferry (Idaho)
   c. Lookout Pass (Idaho/Montana)
   d. Upper Selway (Idaho)
   e. Lost Trail Pass (Idaho/Montana)

f. Monida Pass (Idaho/Montana)
g. Rogers/MacDonald Pass (Montana)
h. Tetons (Wyoming)
i. Southern Sierra
j. Central Sierra
k. Southern Cascades
l. Northern Cascades

Physiographic Area

The overall goal is to maintain or restore metapopulation viability as defined by having a 95% probability of persisting for 500 years. By definition, a metapopulation consists of an aggregate of interacting subpopulations with finite lifetimes (Gilpin and Hanski 1991). Subpopulations are usually separated by semipermeable barriers, but may also be isolated by geographic distance alone. Dispersal (immigration and emmigration) is the dominant process linking subpopulations into a metapopulation. Subpopulations are represented by a group of <u>regularly</u> interbreeding individuals.

A. Objectives

1. Maintain the short-term viability (≥95% probability of persistence for 100 years) of 80% or more of all subpopulations within a single metapopulation.

2. At least 80 percent of all subpopulations should be linked to other subpopulations by a functional corridor. Subpopulations should be within 29 km (18 miles; 75% of the maximum dispersal distance of 38 km [24 miles]; Jones 1991) of each other. The function of a corridor at this scale is to provide for the successful dispersal of young among subpopulations, and to allow for the recolonization of extirpated subpopulations. If subpopulations are isolated by greater than 29 km (18 miles), and suitable habitat exists, reintroduction should be considered to establish a "stepping stone" subpopulation linking the extant subpopulations.

3. Manage a central "core" or "reservoir" subpopulation as a source of immigration for satellite subpopulations within the metapopulation.

4. Establish a refuge within the core subpopulation protected from direct or incidental trapping mortality. This will provide a "source population" for the core subpopulation, and subsequently, for the metapopulation.

B. Assumptions:

1. Habitats within the linkage should be at least suitable for dispersal (i.e., suitable for travel, but not necessarily comprised with preferred habitats) if less than 10 km in length. Corridors longer than 10 km should provide the resources to allow for temporary residency and should contain some preferred resting and foraging habitats. Generally, the longer the linkage zone, the wider it should be.

2. The larger the "reservoir" subpopulation or refuge, the longer the persistence time.

3. Until population simulations have been completed, it will be assumed that refugia within core populations should support at least 14 adult females and 7 adult males. Within the Northern Rocky physiographic region, this size is estimated to be 600 km^2.

C. Methods

1. Validate metapopulation boundaries identified at the physiographic region scale (decreased map scale will increase precision of vegetation and animal distribution maps).

2. Delineate potential habitat within each metapopulation.
   a. Map: GAP or similar.
   b. Scale: 1:250,000 to 1:1,000,000
   c. Potential habitats should be classified as preferred, suitable, or suitable for travel. The following list is comprised of habitats which have been classified as being suitable within the Northern Rocky Mountain physiographic region. Local biologists more familiar with the Coastal, Cascade, and Sierran physiographic regions should develop similar lists.

      1) Preferred Cover Types
         a) Grand fir
         b) Western red cedar
         c) Forested Riparian (cottonwood, aspen, spruce)
      2) Suitable Cover Types
         a) Westside Douglas-fir
         b) Spruce-fir
         c) Subalpine fir
         d) Lodgepole pine
         e) Mixed conifer
      3) Suitable for travel (the above plus). These habitats would likely be avoided, but still usable.
         a) Aspen
         b) Birch
         c) Whitebark pine
         d) Limber pine
         e) Ponderosa pine
         f) Mountain hemlock
         g) Alpine larch

3. Identify absolute barriers, semipermeable, and temporal barriers to fisher movements. Absolute barriers probably exist if unsuitable habitat patches exceed 300 m wide, or if avoided habitats exceed 2.5 km wide. Semipermeable barriers may exist when suitable, but avoided habitats are greater than 100 m, but less than 2.5 km wide. Major highways having right-of-ways greater than 60 m wide would also be considered a semipermeable barrier. Temporal barriers consist of early successional stages (e.g., grass-forb, or seedling-sapling stands) avoided by fishers of suitable forested habitats

exceeding 100 m wide. In that temporal barriers are temporary in nature, they should have their own unique map descriptor.

4. Delineate subpopulations as defined by the above barriers.

5. Inventory potential subpopulations to determine occupancy.

6. Identify linkages among subpopulations.

7. Delineate administrative reserves (i.e., Wilderness and "officially" proposed Wilderness Areas; National Parks, National Wildlife Refuges, and lands not allocated as being suitable for timber management). Potentially, these lands may provide suitable refugia or core subpopulations

8. Overlay historic and current distribution maps. Identify occupied and vacant habitats.

9. Identify a potential "core" subpopulation for each metapopulation. A core subpopulation should be: 1) currently occupied by fishers; 2) centrally located in respect to the other subpopulations within the metapopulation; 3) buffered from human activity and major development; 4) comprised of a relatively high proportion of preferred habitats; and 5) relatively large in respect to the other subpopulations.

D. Guidelines:

1. If a corridor or linkage between subpopulations is less than 16 km long, its width should be at least 2.5 km if longer than 16 km, its width should be at least 5 km.

2. Corridors should follow drainage bottoms (Stream orders 1-4) as much as possible.

3. No more than 25% of the linkage should consist of an opening (i.e., $\leq$30% canopy cover).

4. Road densities within the linkage and accessible to trappers, should be no more than 0.2 km/km^2 (0.3 mi/mi^2) if corridor length exceeds 5 km.

5. Trapping of terrestrial furbearers should not be permitted within refugia to prevent the incidental capture of fishers.

6. Habitat within the refugia should be managed as high quality fisher habitat (defined under subdrainage discussion). In the Northern Rocky physiographic region, approximately 65 to 75 percent of the refugia should be comprised by late-successional forest (120 years of age or older); the remainder should contain 10 to 25 percent young forests; and 10 to 25 percent pole/sapling or younger (less than 50 years old).

Major Watershed

A major watershed is comprised of a fourth or fifth-order stream, and is likely to be 300-600 km^2. The overall goal at this scale is to maintain the short-term viability (95% probability of persistence for 100 years) of the subpopulation. However, it is recognized that stochastic processes may temporarily cause the extirpation of a subpopulation.

A. Objectives

1. Maintain or restore quality fisher habitat across the landscape, consistent with ecological processes, and sustainable through time.

2. Maintain connectivity among home ranges, and of preferred habitats within home ranges.

B. Assumptions:

1. Although fishers prefer late seral forests, a diversity of forest age-classes will likely be more productive for fishers over time. Similarly, landscapes whose structure and composition fall within the "natural" range of variability will support more fishers through time.

2. Adult females, because of their increased energy demand while raising kits, are likely most sensitive to landscape composition and structure. Furthermore, reproductive success may be partially limited by the ability of females to acquire resources while limiting energy expenditure. Therefore, overall population requirements of fishers may potentially be met by providing for the needs of adult females. Limited data from Idaho suggests there may be an inverse relationship between female home-range size and the percentage of the home range comprised by late-successional forests (Jones unpubl. data). The landscape compositions recommended below are based on known quantities within the home ranges of the marked female fishers in Idaho (Jones, unpubl. data).

3. Roads are directly correlated with trapper access, and consequently, fisher vulnerability to trapping. Roads bisecting, or parallel to preferred fisher habitats (e.g., riparian coniferous forests) have the greatest potential to increase fisher vulnerability.

C. Methods

1. Validate subpopulations boundaries delineated at the physiographic area scale (decreased map scale will increase precision of vegetation maps).

2. Delineate potential habitat within the major watershed. Habitat should be classified as preferred, suitable, or suitable for travel.
   a. Map: GAP or similar.

b. Scale: 1:100,000
c. Example of potential habitats, developed for the Northern Rocky Mountain physiographic region:

1) Preferred Cover Types
   a) Grand fir
   b) Western red cedar
   c) Forested riparian (cottonwood, aspen, spruce)
2) Suitable Cover Types
   a) Westside Douglas-fir
   b) Spruce-fir
   c) Subalpine fir
   d) Lodgepole pine
   e) Mixed conifer
3) Suitable for travel (the above habitats, as well as:)
   a) Aspen
   b) Birch
   c) Whitebark pine
   d) Limber pine
   e) Ponderosa pine
   f) Mountain hemlock
   g) Alpine larch

3. Identify absolute, semipermeable, and temporal barriers.

4. Classify lands as to their trapping-vulnerability risk. Use a "moving-window" technique (C. Servheen, pers. comm.) for identifying vulnerability-risk classes where GIS capabilities exist. In lieu of GIS techniques, use subdrainage boundaries for determining road densities.
   a. For areas having fisher or marten trapping seasons: Low risk = $\leq$0.25 miles/mi^2; Moderate risk = 0.25-1.00 miles/mi^2; High risk = $\geq$1.00 miles/mi^2.
   b. For areas with trapping seasons for other terrestrial furbearers: Low risk = $\leq$0.75 mi/mi^2; Moderate risk = 0.75-2.00 mi/mi^2; High risk = >2.0 mi/mi^2.
   c. For areas with no terrestrial furbearer seasons: all areas = low risk.

5. Classify major watersheds as a Primary or Secondary Fisher Conservation Areas (PFCA or SFCA, respectively) using maps of potential habitat. These designations will be based on the inherent quality of fisher habitats. PFCAs are defined here as having at least 50% suitable or preferred habitat, with at least half of this area comprised of preferred habitat. The suitable and preferred habitats should be well distributed and inter-connected across the watershed. SFCAs should have a minimum of 30% suitable or preferred habitat well distributed and inter-connected across the watershed. Fisher Conservation Area designations should be made in consultation with adjacent Forests, state wildlife management agencies, and other state and federal land management agencies.

D. Guidelines

1. Conduct analyses to predict the natural range of variability of landscape structure and composition and manage the landscape within those predicted bounds. In PFCAs, manage the percentage of the landscape in late-seral forests towards the higher end of the natural range of variability. In watersheds classified as SFCAs, the amount of late-seral forests maintained can be at the lower end of the natural range of variability.

2. In the absence of the above landscape analyses, manage as follows:

   a. Primary Fisher Conservation Areas

      Maintain at least 30% and 40% of the suitable sub-drainages as high and moderate quality habitat, respectively (see definitions in "subdrainage" section). No more than 30% of the sub-drainages should be managed as low quality fisher habitat.

   b. Secondary Fisher Conservation Areas

      Maintain at least 20% and 30% of the suitable subdrainages as high and moderate quality habitat, respectively. No more than 50% of the subdrainages should be managed as low quality fisher habitat.

3. Vulnerability:

   a. Primary Fisher Conservation Areas

      No more than 20% of the watershed should be designated as having a "high risk" to trapping. Conversely, at least 40% of the watershed should be classified as "low risk". At least 50% of the watershed should be at least 2.5 km from any road or trail accessible to motorized trapping access.

   b. Secondary Fisher Conservation Areas

      No more than 30% of the watershed should be designated as having a "high risk, and at least 30% of the watershed should be classified as "low risk". At least 30% of the watershed should be at least 2.5 km from any road or trail accessible to motorized trapping access.

   c. Construction of loop roads should be discouraged.

   d. Avoid locating roads along, or through drainage bottoms and saddles.

4. All major watersheds should be interconnected by functioning corridors comprised of habitat suitable for travel. The dendritic pattern of forested stream courses provides preferred travel networks, and are used extensively by fishers (deVos 1951, Buck 1982, Mullis 1985, Jones 1991, Heinemeyer 1993). Forested saddles, linking adjacent major drainages, may serve as potential travel routes, and may be

especially important for fisher movements. A canopy cover of at least 40% should be maintained in critical saddles. Gaps (i.e., areas having less the 30% canopy cover) within potential travel corridors should not exceed 100 m.

Subdrainage

The overall goal at this scale is to maintain functional home ranges. Subdrainage size may vary from 25 to 250 km^2.

A. Objectives

1. Maintain connectivity of suitable habitats within the subdrainage.

2. Maintain quality habitat within the subdrainage.

B. Methods

1. Identify preferred, suitable, and suitable travel habitat.
   a. Map: Timber Stand Management Record System (TSMRS) stand map or similar.
   b. Scale = 1:24,000
   c. Potential Habitats - same habitat series as described for major drainage level. Precision will be increased at a reduced scale.

2. Identify age classes of suitable and preferred fisher habitats.

3. Estimate size of suitable and preferred habitat patches.

4. Identify potential barriers

5. Delineate all roads accessible by trappers during the trapping season.

6. Classify fisher security areas, or vulnerability risk areas, depending on the technology available.

D. Guidelines

1. Maintain habitat structure and composition within the range of natural variability. Where landscape analyses have not been conducted to determine the range of natural variability then:

   High Quality Subdrainage: Should be selected as the subdrainages within the watershed with the relatively highest proportion of preferred habitats. These are then managed to maintain 65-75% of the preferred and suitable habitat as mature or older forests, 10-25% in each of the young and pole/sapling age-classes. At least 80% of these patches should be interconnected by travel corridors comprised of closed-canopy forest (i.e., ≥40% canopy cover). Mature and old-growth patches should be a minimum of 50 ha (125 ac) and should have a minimum of 75% of

their perimeter adjacent to forested sites (i.e., pole stage or older, and ≥40% canopy cover).

Moderate Quality Subdrainage: Maintain at least 40% of the preferred and suitable habitat as mature or older forests. At least 60% of these patches should be interconnected by travel corridors comprised of closed-canopy forest (i.e., ≥40% canopy cover). Mature and old-growth patches should be a minimum of 32 ha (80 ac) and should have a minimum of 50% of their perimeter adjacent to forested sites (i.e., pole stage or older, and ≥40% canopy cover).

Low Quality Subdrainage: These should be selected based on having the lowest relative proportion of preferred habitats within the watershed. Within these subdrainages, 30-40% of the preferred and suitable habitat should be maintained as mature or older forests. At least 40% of these patches should be interconnected by travel corridors comprised of closed-canopy forest (i.e., ≥40% canopy cover). Mature and old-growth patches should be a minimum of 24 ha (60 ac) and should have a minimum of 30% of their perimeter adjacent to forested sites (i.e., pole stage or older, and ≥40% canopy cover).

2. Forested drainage bottoms are ideally suited for travel corridors, linking preferred habitats within and between major watersheds. Gaps (i.e., areas having less than 30% canopy cover) within potential travel corridors should not exceed 100 m.

3. At least 0.5 km/km of the suitable forested perimeter between subdrainages should be managed as movement corridors, suitable for travel. Saddles linking adjacent sub-drainages are probably especially important for fisher movements. At least 40% canopy cover should be maintained in these areas.

4. Construction of loop roads should be discouraged, as should the location of roads along or through drainage bottoms and saddles. Use temporary roads when possible; obliterate, return to contour, and litter with right-of-way slash to discourage trapper access. Closed specified roads should also be littered with slash when feasible.

Stand

The goals at this level are to maintain stand structure and composition within the range of natural variability for all stands, and to maintain stand structure suitable as resting and/or foraging for those stands identified for fisher management at the subdrainage level.

A. Objectives

1. Stands which are managed for timber products should be treated in a manner to allow for the rapid recolonization of preferred prey species (e.g., snowshoe hare, red-backed voles), and subsequently, fishers.

2. Manage forested-riparian areas conservatively.

B. Guidelines

1. Only uneven-aged management prescriptions should be permitted in stands identified to be managed as fisher habitat. For group-select harvest prescriptions, openings should not exceed 0.4 ha (1 ac) in size. Individual-tree select prescriptions should maintain the approximated stand structure outlined in Table 7.

2. Tree marking guides should favor the retention of large diameter tree species preferred as rest sites, particularly those containing witches brooms (e.g., Engelmann spruce).

3. Stands within forested riparian areas are particularly important for fishers; fishers in the west may be dependent upon them. In the Northern Rockies, these important areas would be most likely found within the Abies grandis/Senecio triangularis, Thuja plicata/Athyrium filix-femina, T. plicata/Oplopanax horridum, A. lasiocarpa/Streptopus amplexifolius, A. lasiocarpa/Calamagrostis canadensis, A. lasiocarpa/Oplopanax horridum, and Picea/Equisetum arvense habitat types (Pfister et al. 1977, Cooper et al. 1987). Stands within these types, and any stands within 30 m (100 ft) of water should only be treated using uneven-aged silvicultural prescriptions. Individual-tree select and group-select harvest prescriptions are preferred if management is deemed necessary. Groups should be no larger than 0.1-0.2 ha. At least 70% canopy cover should be retained in stands managed with individual-tree select prescriptions.

4. Implement the following guidelines in stands regenerated with even-aged silvicultural prescriptions, in lieu of knowing the range of natural variability of stand structural characteristics:

   a. Retain at least 12 trees/ha, greater than 46 cm dbh, for future snag and den log recruitment. Preferred species include cottonwood, grand fir, and cedar (or any other species susceptible to heartrot, and tending to be hollow).

   b. Retain ≥50-100 tons/ha of large diameter logs for prey habitat and future rest sites.

   c. Retain cull log decks and a some slash piles (1 per 2 ha) for potential fisher rest sites and prey habitat.

   d. No more than 60 percent of regenerated stands should be precommercially thinned (to maintain snowshoe hare habitat). Leave patches (at least 1 ha) distributed throughout the unit.

Table 7. Habitat structure recommended to maintain quality fisher habitat in the Northern Rocky physiographic region (from Jones 1991).

Variable	Value
Canopy Cover	70%
Live Trees	
2.5-10 cm dbh	1500/ ha (600/ac)
10-20 cm dbh	190/ha (76/ac)
20-33 cm dbh	107/ha (43/ac)
33-46 cm dbh	55/ha (22/ac)
46-61 cm dbh	27/ha (11/ac)
Snags	
15-23 cm dbh	70/ha (28/ac)
23-33 cm dbh	45/ha (18/ac)
33-51 cm dbh	20/ha (8/ac)
>51 cm dbh	10/ha (4/ac)
Logs	
15-20 cm dbh	40 cu m/ha (567 cu ft/ac)
20-33 cm dbh	76 cu m/ha (1093 cu ft/ac)
33-46 cm dbh	57 cu m/ha (811 cu ft/ac)
>46 cm dbh	36 cu m/ha (506 cu ft/ac)

C. Assumptions

1. Maintaining stand structure and composition within the natural range of variability will maintain fisher habitat over the long-term (≥ 1 timber rotation).

2. Regenerated stands retaining a high amount of standing and downed dead material will be recolonized by prey species, and subsequently fishers, at a faster rate than those stands lacking coarse woody debris.

3. Any amount of timber harvest at the stand scale will decrease the suitability of fisher habitat.

D. Methods

1. Map preferred and suitable fisher habitat.
   a. Scale = 1:15,000 to 1:24,000.
   b. Preferred/suitable types are same as those under the major drainage.

2. Determine how stand has been allocated for fisher management at higher hierarchical levels.

3. Determine the range of natural variability for stand structure and composition.

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PART III: BIBLIOGRAPHY

INTRODUCTION

This bibliography contains 160 citations of fisher literature. Although the emphasis of this document is on fisher in western habitats, the majority of the research on fishers has occurred in eastern locations. Annotations of papers (139) which may contribute to the understanding of fisher ecology and management were included in the bibliography. The majority of the annotations prior to 1989 were taken from Banci (1989). These annotations are denoted with a "1" in front of the description.

The references are in alphabetical order. After each citation, there may be up to 4 descriptions. A list of key words in alphabetical order may be below the citation. On a new line may be the dates in which the research took place. In bold type, there may be a 1-2 line statement of the essence or objectives of the paper. Finally, the annotation, abstract, or executive summary follows. Comments by the authors or by Banci (1989) are italicized.

LITERATURE

Allen, A. W. 1983. Habitat suitability index models: fisher. United States Fish and Wildlife Service, Biol. Services Program. FWS/OBS 82/10.45. 19 pp.

[1]cover, diets, HSI models, habitat use, reproduction, review
An extensive review of fisher habitat requirements is used to develop an habitat suitability index (HSI).

HSI MODEL: Season - year round. The life requisite being modelled is "winter cover". If suitable winter cover is not present, the needs of fishers in other seasons will not be met. It is assumed that a minimum of 259 km^2 of potentially suitable contiguous habitat must be present before an area will be successfully inhabited by a population of fishers. Smaller forest areas are unsuitable if isolated. Variables in the model are "percent forest canopy", "average dbh of overstory", "tree canopy diversity", and "percent overstory comprised of deciduous species". *(Thomasma 1988 presents a first attempt at verification).*

Allen, G. M. 1942. Extinct and vanishing mammals of the Western Hemisphere. American Committee for International Wildlife Protection. No. 11, p. 174-181 (fisher).

Anderson, E. 1970. Quaternary evolution of the genus Martes (Carnivora, Mustelidae). Acta Zoologica Fennica. 130. 132p.

[1]age determination, distribution (map), marten, morphology, skull, systematics, subspecies, taxonomy
A systematic study of Pleistocene and recent Martes, their Quaternary history, distribution, relationships, and taxonomy.

TAXONOMY: Subspecific variation in east and west populations of fishers is not apparent.

FISHER AND MARTEN DISTRIBUTION: Ranges are similar but the fisher's northern limit is 10^{o} south of marten. The 2 species extend equally far south in the Pacific mountains. The fisher has a more restricted range in the Rocky Mountains and a more extensive one in the East. Fisher also differ from marten in that they do not occur on the western coastal islands, in Alaska, nor in northern Canada. The fisher's southern limit in the Rocky Mountains is Yellowstone National Park.

PHYLOGENY: The genus Martes occurs in 3 subgenera, Martes, Pekania, and Charronia. Martes pennanti is the sole representative of the subgenus Pekania. It differs from the true martens by its large size and an external median rootlet on P^4 (absent in the subgenera Martes and Charronia). Fishers can be traced back to the middle Pleistocene from M. diluviana, and from the Chinese Pontian form, M. palaeosinensis. Modern fisher is known from the late Pleistocene and postglacial deposits in the U.S. The earliest known occurrence is from the late Wisconsin but fisher may have come across from China in late Illinoian or early Wisconsin times. The historical M. diluviana is probably not directly ancestral but is the fisher's ecological forerunner.

SKULL: "The powerful skull of M. pennanti is characterized by a short rostrum, long postorbital region, and expanded occipital region...As in other mustelids, the postorbital constriction decrease with age while the zygomatic breadth increases." Fisher have relatively large, robust teeth which are morphologically similar to marten. Noticeable sexual dimorphism occurs in almost all tooth measurements of fishers.

Anderson, E. 1991. Evolution, prehistoric distribution and systematics of Martes. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming

distribution, systematics

ABSTRACT: The genus Martes originated in the Palearctic, and its geologic range extends from the early Miocene (19 mya) to the Recent. The fossil history of Martes is poorly known because their forest habitat is not conducive to bone preservation. Many species of Tertiary martens have been described, but most of them are not really martens and only a few were ancestral to living species. The earliest known marten is M. laevidens from lower Miocene deposits in Germany. M wenzensis from the late Pliocene of Poland and M. vetus from the early middle Pleistocene of Germany were probably ancestral to the M. martes line that includes M. zibellina, M. melampus, and M americana. An offshoot of this group is the extinct M nobilis from the late Quaternary of western North America. The ancestry of M. foina is uncertain; the earliest known records are from the last Pleistocene of Israel and southwestern Asia. M. lydekkeri from the Pliocene Siwalik beds in India probably gave rise to M. flavigula and M. gwatkinsi. Fishers first appear in the late Pliocene of China, M. palaeosinensis was probably ancestral to the middle of Pleistocene American species, M. diluviana and the extant M. pennanti.

Martes had a much wider geographic range in the Pleistocene and early Holocene than it does today. For example, M. martes was found in England, M. zibellina inhabited the unbroken taiga from Scandinavia to Korea, M. flavigula was found in China, India and the Malay Peninsula, M. pennanti lived in the Appalachian Mountains south the Tennessee and on the Great Plains in Nebraska. The extinct fisher, M. diluviana, previously known only from the eastern United States, was also found in Canada.

Three subgenera of Martes are recognized: Pekania (fishers) includes the extinct M. palaeosinensis and M. diluviana and the extant M. pennanti; Charronia (yellow-throated martens) includes the extinct M. lydekkeri and the living M. flavigula and M. gwatkinsi (considered a subspecies of M. flavigula by some workers); and Martes (true martens) includes the extinct M. wenzensis, M. vetus and M. nobilis and the extant M. foina and M. martes, M. zibellina, M. melampus and M. americana. The last four species have a Holarctic distribution and replace each other geographically. They show many similarities in morphology, habits and habitat and are often considered a "superspecies." M. americana is divided into the "americana" and "caurina" subspecies groups. The "americana" group arrived first, spread eastward, became isolated by the ice sheet in eastern North America, then re-invaded western Canada and Alaska in the early Holocene. The "caurina" group was a later immigrant from Eurasia and shows a closer relationship to M. zibellina than it does to the "americana" group of subspecies.

Arthur, S. M. 1987. Ecology of fishers in southcentral Maine. Ph.D. Thesis, University of Maine, Orono. 112p.

[1]diets, habitat use, home range use, Maine, mortality, natal dens, radio-telemetry, resting sites
January 1984 - August 1987
The most extensive of radio-telemetry studies on fishers, a relatively large number of collared fishers monitored for a long period provided reliable estimates of home range and habitat use. (This thesis not seen, information was abstracted from 2 unpublished papers written for publication).

The study area (500 km^2) was in an area containing the highest fisher harvest density in Maine: a mean of 1 fisher/ 15 km^2 during 1979-1984. Some townships reported harvests of 1 fisher / 6.7 km^2. The trapping season was 5 weeks, from October to December.

HABITAT: Much of the region consisted of farmland, abandoned during 1880-1980, that had reverted to second growth. Habitats were a mixture of forest types interspersed with small farms and pastures. Balsam fir, hemlock, white pine, oaks, maples and birches occurred in uplands. Red spruce, black spruce, and tamarack occurred in lowlands.

HOME RANGES: Forty-three fishers were captured and radio-collared, 22 adults (≥ 1 year) (11 M, 11 F), and 21 juveniles (< 1 year) (17 M, 4 F). Locations from May to December were used because the home ranges seemed stable in size and location. Home ranges were calculated using 3 methods, convex polygons with all locations, convex polygons and 50 randomly selected locations, and 90% and 99% harmonic mean home ranges (HMH). Only results for the second method are presented here. For 6 females, home ranges were 8.1 - 39.1 km^2 in size (average = 16.3), and for 7 males, the range was 10.6 - 78.2 km^2 (average = 30.9). These means did not differ (t-test). There was only 1 instance of 2 males using an overlap area. However, the overlap was not present in 50% HMH, thus areas of intensive use did not overlap. Similarly, 2 females used an 75 ha overlap, with no overlap present in the 50% HMHs. Female-male overlap was extensive. One incidence of male-male aggression was recorded. Home ranges of females were stable in size and location all year. Males frequently made outside trips during February to April, trespassing in the home

ranges of other adult males for 1-2 days. The median of male home ranges was 25.5 km^2 and 12.2 km^2 for females. The median home range may be a more useful measure because of the large variability in mean home range size.

DENSITY: No transients were present in the population. A maximum density of residents calculated using the median home range was 1/8.3 km^2, and a summer and fall density (including kits) was 1/2.8 km^2. In a core area of 200 km^2, 10 fisher (4 M, 6F) were present, providing a density of 1/20 km^2. The actual density probably was higher because of the presence of non-collared fishers. If reproduction is conservatively estimated as 1.4 young / female, a minimum summer density is 1/10.5 km^2. Thus, actual densities likely ranged from 1/2.8 - 1/10.5 km^2 in summer, and 1/8.3 to 1/20.0 km^2 in winter.

TRAPPING MORTALITY was greatest among juveniles of both sexes (10 of 17), and least among adult females (2 of 13).

HABITAT USE: The year was split into spring (Mar-May), summer (Jun-Aug), fall (Sep-Nov), and winter (Dec-Feb). Habitat use was determined using radio locations and tracking. Availability of habitats within forested lands was determined from transects, as was prey availability. All aerial locations ($n = 782$) were in forested habitat, although only 83% of the study area was forested. Deciduous stands were used proportionately less than available, during all seasons. Coniferous stands were used more in all seasons except summer. Mixed stands were used in proportion to availability during all seasons. Scrub stands were used less during winter and spring. Wetlands were used less in all seasons except fall. For 33.8 km, 56 fisher trails were followed, and availability was estimated using 46.5 km in 18 transects. Fishers used coniferous overstories more, and hardwood, mixed and scrub, less than availability. Stands with no understory and sparse coniferous understories were used most frequently. However, the use by fishers of dense patches containing snowshoe hare trails was underestimated.

RESTING SITES were of 3 types, ground burrows, tree cavities, and tree nests. Nests were used most often all year, generally in "witches' brooms" (clumped growths) in balsam fir. Squirrel and raptor nests were used occasionally. Ground burrows, likely excavated by woodchucks, were used more in winter. Although fishers tunnelled through snow to burrows, they never used snow dens. Tree cavities were used during fall and spring, when there was no snow, nights were cool ($<0^o$ C) and days mild. All tree cavities were in hollow aspen. These were used from 2-12 weeks. Others were rarely used. Resting sites often occurred in forest blocks <0.5 ha in size. Three adult females used tree cavities as NATAL DENS, all in hollow aspen.

Little evidence for selection by fisher of particular forest types was observed. Patches of snowshoe hare habitat appeared to be important foraging areas but this use was not quantified. There was no indication of fisher searching for porcupine or dens. Only male fishers were found with fresh quills. Fishers may be better adapted to deciduous and transitional habitats, rather than northern coniferous forests. Mature coniferous forest may not be optimum fisher habitat because deep snow restricts fisher movements. In the southern part of its range, optimum habitat is a diversity of forest types with high interspersion. The quality of habitat decreases when stands are >75% conifers. Small (≤5 ha) forest openings provide diversity. Fishers tolerated a high degree of human presence.

DIETS: From December to March, 68 scats collected on trails contained 20 food types. Apples were a major food item, comprising 34% of all scats. Apples were common around abandoned farms, which usually supported mixed second growth forest. Other identified foods were sciurids (25%), porcupine (21%), small mammals (22%), snowshoe hare (18%), birds (13%), and deer (7%). Because of the mild winters, carrion was uncommon in the study area.

Arthur, S. M. 1988a. An evaluation of techniques for capturing and radiocollaring fishers. Wildl. Soc. Bull. 16:417-422.

[1]immobilization, livetrapping, Maine, radio-telemetry, techniques
Methods of trapping, recapturing, and radio-collaring fishers are reported and evaluated.

Forty fishers were captured using cages, radio-monitored cages, and padded-jaw foothold traps. The highest capture rate was in radio-equipped cages (1.94 captures/trap-night), probably because human scent was minimized. Trapping was most successful during October, March and April. Most (15) juvenile males were caught in October (1.52/trap-night), as were adult females (0.81/trap-night), and adult males were captured most frequently in March. Trapping of females during late March-April should be avoided because of denning. Fishers were recaptured using jab sticks, by darting, and by excavating burrows. Ear-tagging was unreliable because most fishers lost 1 or both tags over 3-12 months. Fishers were immobilized with intramuscular injections of ketamine hydrochloride, at doses of 20-60 mg/kg of body weight.

Arthur, S. M. 1988b (abstract). Behaviour and reproductive ecology of fishers in south-central Maine. Am. Soc. Mammalogists, 68th Ann. Meeting, Clemson, S.C.

[1]behaviour, breeding, movements, natal dens, reproduction

ABSTRACT: Fisher (Martes pennanti) reproductive ecology was studied by observing movements of 43 radiocollared fishers in south-central Maine from February 1984-August 1987. During the March-April mating season, males travelled extensively outside their established ranges, but females did not change their movement patterns. Six females produced offspring in tree cavities. Natal dens were used for 8-12 weeks beginning in March or early April. Females with young were more active during summer than those without offspring. Juveniles remained with their mothers at least until August, and were independent by the end of September. Juvenile males travelled extensively during fall, winter, and spring, before establishing stable ranges during their second summer. The maximum denning rate during the study was 75%, in contrast to pregnancy rates of ≥95% found by previous studies. I propose that reproductive success may depend on the physical condition of females during fall or winter. Delayed implantation may allow mating to occur at a time of low energy demand on both males and females, and to allow females to interrupt gestation if they are not in sufficiently good condition during winter.

Arthur, S. M. and W. B. Krohn. 1991. Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J. Mamm. 72:379-385.

Arthur, S. M., W. B. Krohn, J. R. Gilbert. 1989. Habitat use and diet of fishers. J. Wildl. Manage 53(3):680-688.

behavior, diets, foraging, habitat use, Maine, management, movements, porcupine, radiotelemetry, resting sites, snowshoe hare
An intensive study of the habitat use and diet of 43 radio-collared fishers in Maine from January 1984 to August 1987.

ABSTRACT: We studied habitat use and diets of 43 radio-collared fishers (Martes pennanti) in south-central Maine from January 1984 to August 1987. Coniferous stands were preferred for rest sites during spring, summer, and fall when fishers usually rested in the branches of coniferous trees. During winter, fishers usually rested in ground burrows in mixed stands. Active fishers used a variety of forest types, especially during summer. During winter, fishers hunted intensively in dense patches of coniferous undergrowth, where snowshoe hare (Lepus americanus) tracks were common, and used deciduous stands less than expected by availability. Winter foods included apples, porcupines (Erethizon dorsatum), hares, gray squirrels (Sciurus carolinensis), red squirrels (Tamiasciurus hudsonicus), flying squirrels (Glaucomys sabrinus), mice (Peromyscus spp.), voles (Clethrionomys gapperi and Microtus spp.) ,and shrews (Sorex spp and Blarina spp.). Because of the diversity of the fisher's diet, optimal habitat probably includes a mixture of forest types, including some coniferous cover.

Arthur, S. M., W. B. Krohn, J. R. Gilbert. 1989. Home range characteristics of adult fishers. J. Wildl. Manage. 53(3):674-679.

behavior, density, home range use, Maine, movements, radiotelemetry, spatial patterns
Movements of adult fishers were monitored for 2 years in Maine to obtain homerange estimates from which seasonal, intrasexual, and intersexual comparisons in size and spacing are made. This paper based on Ph.D. research and dissertation (see above).

ABSTRACT: We studied movements of radio-collared adult fishers (Martes pennanti) in south-central Maine from February 1984 through December 1986. Home ranges of females were stable between seasons and years, but males moved extensively from February through April, and their ranges shifted between years. Home ranges occupied from May through December of any year averaged 16.3 and 30.9 km2 for 6 adult females and 7 adult males, respectively (range = 8.1-39.1 and 10.6-78.2 km2, respectively); the means were not statistically different ($t = 1.3$, 11 df, $P = 0.2$). Ranges of adults usually did not overlap with others of the same sex, except for males during spring. Fishers of both sexes shifted or enlarged their ranges to include areas left vacant when others of the same sex were removed. Because ranges were intrasexually exclusive, we used median range size to estimate fisher density (1/2.8-10.5 km2 in summer and 1/8.3-20.0 km2 in winter). Fisher density was near the maximum reported elsewhere, despite intense trapping pressure in the area.

Aubry, K. B. and D. B. Houston. 1991. Distribution and status of the fisher in Washington. Northwestern Naturalist 73:69-79.

distribution, habitat use, Washington

ABSTRACT: We determined the current distribution of fishers (Martes pennanti)

in Washington using sighting and trapping records, and evaluated their occurrence in relation to major vegetation and elevation zones. We obtained 137 records dating from 1894-1991. Martes pennanti still occurs in the Cascade Range and Olympic Mountains and in portions of the Okanogan Highlands, but is apparently very rare. We found no records from the eastern edge of Puget Sound, the Kitsap Peninsula, the southern Coast Range, or the Blue Mountains. Records of M. pennanti west of the Cascade crest were strongly skewed toward low to mid-elevations: 87% were at <1000 m and the remainder were at <1800 m. In constrast, only 30% of records east of the crest were at <1000 m, and 18% were from 1800-2200 m. These patterns may result from deeper, softer snowpacks at high elevations on the west side, which restrict the movements of M. pennanti in winter. Most western records (54%) were from the Western hemlock (Tsuga heterophylla) forest zone; remaining records were from the Pacific silver fir (Abies amabilis) zone (26%) and the Sitka spruce (Picea sitchensis) zone (20%). Most eastern records (53%) were from the Subalpine fir (Abies lasiocarpa) zone; others were from the Grand fir (Abies grandis)/Douglas fir (Pseudotsuga menziessii) (37%) and Timberline/Alpine zones (10%). We predict that available habitat for fishers would be enhanced by minimizing forest fragmentation, maintaining high forest-floor structural diversity, preserving snags and live trees with dead tops, and protecting swamps and other forested wetlands.

Aune, K. and P. Schladweiler. 1993. Wildlife laboratory annual report. Montana Department of Fish, Wildlife, and Parks, Bozeman.

age structure, harvest, Montana,reproduction, sex ratios
Analysis results from fisher carcasses collected from trappers in Montana (1977-1993).

SUMMARY: Fisher carcass collections will need to be conducted over a long period before detailed evaluations of results can be completed. Previous collections were conducted, however evaluations were inconsistent and processing variable. It is essential that new collections be thoroughly examined to enhance the data used for this preliminary evaluation.

Preliminary data suggests that Montana fisher reproduction may be limited to fisher older than 2 years of age. Yearling fisher are occassionally ovulating. The mean number of corpora lutea for all females older the 1.5 years (2.17) is lower than means reported for Ontario (3.35) and Maine (3.0). More data will be necessary to accurately evaluate the reproductive potential of Montana fisher populations.

Data from stomach and colon analysis suggest that lagomorphs and rodents are the most common prey items in Montana fisher. Further collection of stomach and colon data are needed to examine regional differences in food habits.

Age distributions indicate that a large proportion of the harvest comes from juvenile and yearling fisher. Some individual fisher are surviving to attain ages of up to 9.5 years. No change is evident in age structure of the carcasses collected comparing the pre- and post-1986 periods.

Bailey, V. 1936. The mammals and life zones of Oregon. U.S. Dept. of Agriculture, North American Fauna No. 55:1-416 (fisher p. 298-299).

[1]distribution (map), habitat, Oregon
Distribution, habitat, and life history are described.

The distribution of West Coast fishers ranges from British Columbia south through Washington and Oregon to northern California and through the Coast Ranges. No records are available for the Blue Mountains. In Oregon, fishers occupy the cool humid Coast Ranges and coniferous coastal forest. They "are rarely found far from cover of spruce and pine".

Banci, V. 1989. A fisher management strategy. Wildl. Bull. No. B-63; ISSN 0829-9560 Min. of Env., Victoria, British Columbia.

activity, age determination, behavior, blastocysts, breeding, Canada, condition, density, description, diets, distribution (map), fat indices, gestation, habitat use, harvests, home range, livetrapping, litter size, management, marten, morphology, mortality, natality, parasites, parturition, pelts, population cycles, population models, primeness, re-establishment, reproduction, review, sex determination, skull, techniques, United States

A comprehensive literature review of fisher ecology with an extensive annotated bibliography.

EXECUTIVE SUMMARY: The fisher belongs to the Mustelidae, the family that also includes wolverines, otters, weasels and martens. The fisher is closely related to the North American marten. Both species share the same genus, Martes. Fishers only occur in North America. British Columbia represents the northern limit of the distribution of fishers although a few stray into the northeast corner of Yukon. Fishers do not occur in Alaska nor on the coastal islands.

Fishers are susceptible to overtrapping and habitat loss. During the late 1800's and 1920's, fisher pelts were worth up to $300 and demand was high. Overtrapping, habitat losses from settlement and logging, and the widespread use of poisons as a predator control agent and as a means of trapping caused populations reductions in many areas. By the 1930's fishers were almost exterminated in the United States. Fortunately, fishers have the ability to rebound quickly. They have been reestablished in most of their former range by habitat improvement, control of harvests and trapping, and in some areas by transplants. North American harvests during the 1970's and 1980's are higher than they have ever been. However, compared to other species, such as the marten, harvests are small. This is because fishers occur at low densities, they are solitary, have small litters, and large home ranges compared to carnivores of similar size.

DESCRIPTION: Males are the larger sex, they weigh 3-5 kg, and females weigh 1-2 kg. Females have darker, silkier furs than do males and are worth more on the market. Small juvenile males have fur intermediate in quality between females and older males. There are no recognized subspecies of fisher, although eastern Canada appears to produce a better quality fur than western Canada. The presence of the large saggital crest on the top of the skull indicates an adult in males. In females, the presence of a saggital crest also indicates an adult, but not all adult females have saggital crests. The baculum, the penis bone of males, increases in weight and changes in shape and age. All females that are pregnant are adults.

REPRODUCTION: Like wolverine and marten, fishers have delayed implantation. Kits may be born from January to April, but most births occur from March to April. The timing of implantation likely depends on food availability and on the condition of females. Litter sizes are small, ranging from 1-4, with 2-3 being average. Females go into heat 2-10 days after giving birth. Breeding generally occurs from late February to the middle of April. Females do not mate until their second spring and

have their first litter at 2 years of age. Not all females within a population may be pregnant. Pregnancy rates in carcass samples have ranged from 73% to 100%. Studies on live fishers in Maine indicate that even if a female is pregnant, she may not have kits. Females have delayed implantation and may interrupt their pregnancies if they are not in sufficiently good condition during the winter.

DIETS: Fishers eat a diversity of foods although snowshoe hare and porcupine are frequent prey. Other foods which have been documented in diets are carrion (deer or other ungulates), voles, mice, shrews, moles, muskrats, beaver, rabbit, raccoon, marten, birds (especially grouse and jays), snakes, fish, eggs, vegetation, nuts apples, beechnuts, and fungi. The food groups snowshoe hare, porcupine, deer, squirrels, small mammals, and birds can be considered the staples of the fisher diet. Smaller prey, such as mice and squirrels, are more important when large prey are unavailable. When a prey becomes more abundant, such as during an increase in the snowshoe hare cycle, fishers rely more on that prey type and use other prey less. In Manitoba, fishers frequently ate ducks, particularly during early winter when large migratory flocks frequented the area. Similarly, muskrats were common in shallow bays of lakes and were an important food. Apples were important in the winter diets of fishers in New Hampshire and Maine, because they were readily available in those habitats.

All species of squirrels and all species of small mammals are eaten, depending on what is common in the environment. Deer and moose are consumed as carrion. Fishers return to old kill sites during cold, stormy weather, when other food is unavailable. Returning carcasses to the trapline, especially during times of low food availability, will benefit fishers. Fishers in summer and fall eat a greater diversity of foods, including fruits and nuts. Few differences in diets occur between sexes although the smaller female may not be able to kill large porcupines, those more than 7 kg in weight

The fisher-porcupine relationship has been documented frequently and fishers have been transplanted into areas for porcupine control. Fishers hunt porcupine in open, upland, hardwood forests, travelling in long distance (up to 5 km), straight line movements directed to porcupine dens. They kill porcupine by repeated attacks to the unquilled face, a method apparently unique to this species. For all other prey, the hunting behaviour of fishers is characterized by frequent changes in direction and zig-zags. They hunt prey near and in overturned tree roots, downed logs and brush piles.

Most of the prey of fishers display population "highs" and "lows". Populations of mice and voles commonly fluctuate every 3-4 years and hares and grouse have a 9-10 year cycle. Fishers are affected by the periodic abundances of prey, however, trends in population size are not predictable.

MORTALITY: Fishers appear to have few enemies besides humans. Although many parasites have been documented in and on fishers, few have ill effects. Sarcoptic mange, a contagious skin disease caused by a mite, has been found on fishers. These mites damage the pelt and may be a serious mortality factor, if infestations are heavy. Fishers are frequently pierced by porcupine quills. Quills carry no poisons or irritants and have no characteristics that could cause infections but the occasional injury does occur.

HABITAT: Habitat studies indicate that fishers frequent ecotones and edges, the transition areas between different types of habitats, and riparian areas, those that are associated with rivers and streams. Fishers are not as dependent on climax coniferous forests as are marten. Generally, they occur at the middle range of elevations and changes in elevation between seasons do not occur. Deep snow

hinders the movements of fishers and affects their use of habitats in winter. Fishers active on soft snow may use 54% more energy per day than fishers on hard snow. Because of their larger size, fishers are affected to a greater extent than are marten. The effects of snow cover may be important in understanding why marten occur in habitats where fishers are absent. The lack of fishers in coastal habitats is likely because of the deep, wet snow in these areas.

Dens used as resting sites by fishers are diverse and include snow dens, hollow logs, holes in the ground, witches brooms, squirrel nests, and raptor nests. Natal dens, however, almost exclusively occur in cavities in large dead trees, located 7-12 m above the ground. Tree cavities provide thermal protection for kits, protection from adult male fishers, and security from predators. A secure den is especially important considering a female may leave her kits unattended for long periods.

Reserves of unlogged and untrapped wilderness have been important in the reestablishment of fisher populations. Such reserves not only provide a source of dispersing fishers for trapped regions but are insurance against population reductions. Trappers may be able to maintain adequately sized reserves on their traplines but the size of this area will depend on habitat quality.

HOME RANGE SIZE AND MOVEMENTS: Home ranges of adult males are 20-34 km^2 in size, and for adult females, 15-19 km^2. Males have larger home ranges and their movements are greater than for females. The spatial system of fishers appears to be similar to that of other mustelids, where the range of 1 male overlaps ranges of more than 1 female, but home ranges within sexes do not overlap. Female home ranges change little in size throughout the year. Adult males abandon their home ranges during the breeding season, February to April, in search of females in heat. They are very susceptible to being trapped at this time. The movements of juveniles during the dispersal may be extensive. Fishers may travel long distances, movements of 13-16 km in 1 day and 97 km in 3 days have been documented.

HARVESTS: A female bias, specifically in adults, appears to be common in fisher harvests. Because males are more vulnerable due to their greater movements and larger home ranges, more of them are expected to occur in the harvests. When populations are lightly trapped, more males do occur in the harvests. When populations are being trapped intensively, however, more females are trapped. This likely means that there are more females in the population. This is a problem if there are too few males available to impregnate all the females. When fisher populations in Ontario were trapped heavily, barren females began to appear in the harvests. After the trapping season was truncated to the end of December and quotas were reduced, all females in harvest were pregnant.

Why females outnumber males in fisher populations is not clear. Males in harvests are typically not older than 4-5 years, while females may reach 11 years in age. The sex bias in Ontario harvests was not evident until males were 2-years-old, implying that juvenile males had a high mortality. Pelt scarring was also more frequent in males, and most frequent in juveniles. Juveniles may be attacked by adult males, likely during the breeding season. Adult females have the lowest mortality of all age groups. Females outnumber males probably because of their lower mortality and a higher mortality of males.

DENSITIES: Densities estimated for regions in eastern North America are relatively high, ranging from 1 fisher/0.6 km^2 to 1.18.9 km^2. The estimates from western regions, British Columbia and California, are >1/200 km^2. Densities in the west are likely lower than in the east but considering that home ranges are less than 100 km^2 in size, these estimated densities are too low. Information is insufficient to estimate

densities and population sizes of fishers in British Columbia.

FISHER AND MARTEN: It has been suggested that competition between fishers and marten may be an important factor controlling distributions and population levels. Fishers and marten often do not occur in the same area and the two species appear to use different kinds of habitats. Fishers occupy lower elevations and are better adapted to earlier successional stages of forests than are marten. Marten are smaller and are more arboreal, they are better able to hunt under the snow during the winter, and they are less restricted by snow cover than fishers. The requirements for suitable resting sites in winter by marten may be more specific than for fishers as marten are not efficient at retaining body heat.

MANAGEMENT: The numbers of fishers present on a trapline depends on habitat quality, reproduction, and the habitat quality of surrounding traplines. Fishers prefer diversity in habitat, thus riparian areas, ridgelines, and small forest openings will contribute to habitat quality. One researcher suggested that promoting the growth of alders for beavers would also benefit fishers. Because fishers are also scavengers, the return of carcasses to the trapline will increase habitat quality and may draw in fishers that are dispersing from surrounding or untrapped areas. Because reproduction is tied to food availability, supplementing the trapline with food, especially during shortages, will benefit pregnant females.

The objective in trapline management for fishers is to leave a breeding population and trap dispersing juveniles. Because home ranges are relatively large, this cannot be accomplished by simply staggering trap placement. Large, untrapped areas will maintain a reserve population and provide insurance against population reductions. The size of reserve which is adequate depends on habitat quality and not all traplines may have sufficient habitat to maintain such areas.

Females appear to outnumber males in the population. Thus, if harvests have a large number of males, the population is being trapped lightly. A greater proportion of females means that harvesting is heavy. Because pockets of females may occur, the harvest of one trapper is not necessarily indicative of the entire population. To be useful to the trapper, these harvests need to be combined and presented on a regional basis.

Because of breeding movements, males are more vulnerable to trapping during late winter and early spring. Overtrapping males may result in barren females, thus it is best to trap earlier in the season (before January). Additional benefits of trapping early are that a greater proportion of non-breeders, or juveniles will be trapped and pelts reach peak primeness earlier. Fishers are easily trapped and a proportion may be caught in traps set for other species. A trapper attempting to limit his fisher harvest should avoid placing traps where fisher tracks are present.

Bandy, P. J. 1952. A study of the fur-bearing mammals of the Subalpine and Columbia forest regions of British Columbia in relation to fur production from 1929 to 1949. Unpub. B.A. Thesis, University of British Columbia, 82p.

Banfield, A. W. F. 1974. The mammals of Canada. University of Toronto Press, Ontario. (fisher) p. 318-320.

Blanchard, H. 1964. Weight of a large fisher. J. Mamm. 45:487-488.

[1]Maine, weights

A record weight for a trapped male fisher was 9056 g.

Bradle, B.J. 1957. The fisher returns to Wisconsin. Wisconsin Conservation Bulletin. 22:9-11.

[1]popular account, porcupine, reintroduction, Wisconsin
Fishers were reintroduced into Nicolet Forest, Wisconsin, for porcupine control.

Brander, R. B. and D. J. Books. 1973. Return of the fisher. Nat. Hist. 82(1):52-57.

[1]Canada, diets, distribution, habitat, hunting behaviour, popular account, porcupine, predator-prey relationship, United States
One of the best popular accounts, the authors provide accurate accounts of changes in distribution, reintroductions, diets, and the relationship of fisher with porcupine.

The original range of the fisher was the northern coniferous forest, from coast to coast. By the 1900's fisher populations had declined due to overharvesting and habitat loss. Increased trapper effort was duet to an increase in pelt value. In 1920, fisher pelt prices peaked, a mean of $85 (CAN), to a maximum of $300. Many fishers were also hunted. By the 1930's fisher were almost exterminated in the United States, except for small populations in Maine, the White Mountains (New Hampshire) and Adirondack Mountains (New York), northeast Minnesota, and California. By 1940, fishers were extinct in Nova Scotia. Concerns prompted closure of trapping seasons, 1922 in Wisconsin, 1929 in Minnesota, 1935 in New Hampshire, 1936 in New York and Wyoming, 1937 in Maine and Oregon, and 1946 in California. Seasons were rarely closed in Canada but the registration of traplines helped to control harvests. By the 1950's, demand changed from fisher to spotted cats. Fisher prices dropped to $10-$15 per pelt. Decrease in demand, restoration of habitat, and restocking in some areas helped to increase fisher numbers.

Fishers, as the only animal able to control porcupines, have added public acceptance. In a first release in Michigan, porcupine densities decreased from 94 to 23 per km^2. Reintroduced fisher populations seem to be reaching an equilibrium with porcupine in some areas. A decrease in the number of secure porcupine dens (in live, hollow trees, >20" dbh of yellow birch, elm, sugar maple or basswood) would increase the susceptibility of porcupine to fisher predation and upset the predator-prey balance.

Breton, L., Y. Garant, and M. Crête. 1991. Field anesthesia of pine marten and fishers with isoflurane. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

immobilization

ABSTRACT: Isoflurane, a volatile neuromuscular blocking agent, was tested to anesthetize mustelids in the field because it has limited side effects, it is safe and easy to handle, and it provokes quick recovery. Tests were carried out in September on 21 martens, and in November-December on 12 fishers. Animals were captured in Tomahawk live traps. After capture, each trap was placed inside a closed, snugly-fitted plexiglass box. Box volume was 18,000 ml for marten traps and 90,000 ml for fisher traps. After some trials, 3 and 18 ml of fluid isoflurane were injected on the floor of marten and fisher boxes, respectively. Induction time averaged 107 sec (SE

= 38; n = 9) and 91 sec (40;14) for female and male marten, respectively; in fisher corresponding values were 228 sec (54;5) and 172 sec (45;4). Animals were left in the box for an additional 1-3 minutes until they breathed slowly and deeply, then taken out for weighing, sexing, collaring, tagging and tooth extraction. A second anesthesia was necessary on 6 occasions for marten and on 3 for fisher; with experience one anesthesia was sufficient for completing manipulations. In fisher, anesthesia duration was related to induction time and lasted 325 sec (43;5) for males, and 212 sec (43;5) for females. In marten, anesthesia time was measured in only 4 cases; it averaged 210 sec (SE = 55). No mortality occurred during the anesthesia of 21 marten with isoflurane; however two animals were found dead within 2 weeks of manipulation, one of which seemed sick at the time of capture and may have died from canine distemper. We cannot speculate on what caused the death of the second marten. Three fishers died during manipulation. One male probably died of hypothermia from being exposed to frozen rain the night before. In the other 2 cases, animals were kept with food for 4 and 5 days in their traps at the trapper's place before being handled, due to communication problems. In spite of having eaten the available food, they may have suffered from excessive stress; necropsy revealed a large ventricular hypertrophia in one of these two. Further experiments are necessary before recommending the use of isoflurane for field anesthesia of marten and fisher although we are satisfied with our first trials; but ensuring manipulation within 24 hr of capture should decrease mortality rate to a very low level.

Brown, L. N. 1965. A fisher, Martes pennanti, in Sheridan County, Wyoming. The Southwestern Naturalist. 10:143.

[1]distribution, Wyoming

Fisher are only known from the extreme northwest corner of Wyoming. In 1964, an adult male weighing 7.1 kg was killed 288 km to the southwest from this area.

Brown, M. K. and G. R. Parsons. 1983. Movement of a male fisher in southern New York. New York Fish and Game J. 30:114-115.

[1]dispersal, movements, New York, reintroduction

Fisher were transplanted in 1976 from northern New York to the Catskill Mountains. One 6.3 kg male travelled 136 km in 10 months. This fisher was re-released from the original point and travelled a straight line distance of 163 km in 11 months. These movements may be atypical because this fisher was previously held captive. Two other males transferred from the wild were recovered 2.5 and 17.5 km from release points, and 2 females, 22.8 and 23.5 km from release points. *The time span is not provided.*

Buck, S. 1982. Habitat utilization by fisher (Martes pennanti) near Big Bar, California. M. S. thesis, Humboldt State Univ. 85 pp.

ABSTRACT: Individual range and movement, habitat utilization, and effects of logging on fisher (Martes pennanti) were studied near Big Bar, California, between November, 1977 and June, 1979. Fishers were trapped, immobilized, fitted with radio collars and released. Location data were obtained from trapping, track observations and from air and ground telemetry. Field sampling and U.S. Forest Service timber type maps were used for analysis of habitat.

Thirteen individual fishers were captured during the study. An overall male to female sex ratio of 9:4 was found. The overall age composition was 8:5, adult to juvenile. Mean individual range size for all fishers was 12.6 km^2. Mean range size for males was approximately 15.0 km^2 compared to 8.0 km^2 for females. Adult males had the largest ranges and adult females had the smallest. Juvenile ranges for both sexes were slightly smaller than those for adult males. Range overlap was common, especially among adult male fishers. Adult males showed a tendency to move outside of their ranges during breeding season.

All sex and age classes combined avoided pure hardwood stands and occurred most frequently in stands composed of mature closed conifers. Within mature closed conifer stands fishers occurred most frequently in multiple species stands. Adult males seemed to avoid stands that had a large proportion of hardwoods. Adult females did not seem to avoid hardwood areas. Riparian areas appear to be important habitat for fishers.

The overall effect of logging, especially selective cutting, has been a reduction of preferred mature closed conifer habitat. This may have resulted in the stronger adult males restricting female and juvenile distribution to the less preferred hardwood and mixed conifer-hardwood habitats.

Buck, S. G., C. Mullis, and A. S. Mossman. 1991. Fisher habitat utilization in adjoining heavily and lightly harvested forest. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

California, habitat use

ABSTRACT: Fisher habitat utilization was studied in 1977-1979 on adjoining heavily harvested (HH) and lightly harvested (LH) areas within the Shasta-Trinity National Forest of northwestern California. The areas differed mainly in the amount of pre-salvage logging and roads. Two hundred thirty-nine locations from 12 fishers (8M/4F) in the HH area and 143 locations from 8 fishers (5M/3F) within the LH area were obtained from trap sites, tracks and telemetry. Habitat utilization was determined by identifying U.S. Forest Service timber types at all locations and plant communities at selected locations. We grouped 104 timber types into 11 Timber Type Groups then used chi-square analysis to test fisher preference or avoidance for Timber Type Groups.

In the HH area male fishers preferred mature closed conifer forest and multiple species stands within mature closed conifer forest but avoided all Timber Type Groups that included hardwoods. In contrast, males within the LH area showed no preference for mature closed conifer forest or multiple species stands within mature closed conifer forest and preferred most Timber Type Groups with hardwoods. In both areas female and juvenile fishers showed no preference for mature closed conifer forests.

In both HH and LH areas male fishers occurred more frequently in the denser, more mesic mixed conifer-fir community (relative percent 4% HH, 6% LH). In the HH area female and juvenile fishers were found more commonly in the mixed conifer-pine community (relative percent F 21%, Juv 14%) than in the mixed conifer-fir community (relative percent F 4%, Juv 0%). In the LH area the opposite was true with females and juveniles occurring more often in the mixed conifer-fir community (relative percent F 12%, Juv 32%) than in the mixed conifer-pine community (relative percent F 4%, Juv 12%).

Our interpretation is that the mixture of timber types within LH area more closely met the requirements of all fisher sex and age classes. Extensive pre-salvage logging in the HH area has reduced the percentage of preferred closed conifer forest and

increased the percentage of open areas, open canopy and hardwoods. Within the HH area male fishers were able to maintain their ranges within the remaining mature closed canopy timber types. Our data suggest that within the HH area female and juvenile fishers may be avoiding habitats used by males. They will occur more frequently in less optimal habitats.

Buck, S., C. Mullis, and A. Mossman. 1979. A radio telemetry study of fishers in northwestern California. Cal-Neva Wildlife Transactions. 1979, p. 166-172.

[1]California, home range use, livetrapping, radio-telemetry
November 1977 - December 1978
Objectives were to determine seasonal habitat use; examine the responses of fishers to logging and associated road construction; estimate density; provide information on diets, denning sites, and interactions with other carnivores; and develop management guidelines. Initial results are presented.

The study area was 153 km^2 of the Trinity National Forest. Lower elevations supported Douglas-fir cover types, and higher elevations mixed Douglas-fir types. Eight males (4 adults, 4 juveniles) and 3 females (2 adult, 1 1-year old) were trapped. All captures were on edges or along steams. HOME RANGES were biased by a preponderance of summer data. Home range sizes for 3 adult males were 13.8 (Nov - Sep, n = 47 locations), 10.4 (Feb - Sep, n = 51), and 17.8 km^2 (Mar -Sep, n = 43). Home range sizes for 2 adult females were 6.8 (Nov - Feb, n = 8), and 3.6 km^2 (Feb - Jul, n = 12). An adult male moved out of his regular home range during the breeding season. No seasonal shifts in ELEVATION were observed. Elevations used ranged from 472 m - 1356 m. Three RESTING SITES were located, 1 was underground at the base of a Douglas-fir snag, 2 were associated with downed logs of 75-100 cm diameter.

Bulmer, M. G. 1974. A statistical analysis of the 10-year cycle in Canada. J. Anim. Ecol. 43:701-718.

[1]Canada, furbearers, population cycles, snowshoe hare
The essence of this paper and the succeeding two is that most furbearers, including fishers, exhibit population cycles.

The ten-year cycle has 2 main features, a regular period and an irregular amplitude. A statistical model is developed which includes a dependence on population size, as well as a periodic function. Data were fur harvests of Canada between 1751 and 1969. The 10 year cycle existed, for at least part of this period, for coyote, fisher, red fox, lynx, marten, mink, muskrat, skunk, wolf, wolverine, and snowshoe hare. A simple theory is that the cycle in all species is caused, directly or indirectly, by the cycle in snowshoe hare. *See also Hewitt 1921, Cowan 1938, Butler 1953, Bulmer 1975.*

Bulmer, M. G. 1975. Phase relations in the ten-year cycle. J. Anim. Ecol. 44:609-621.

[1]Canada, furbearers, harvests, population cycles.

It is suggested that the 10-year cycle in any cyclic species, except snowshoe hare, is driven by another cyclic species which either eats it or is eaten by it. A quantitative

model is developed to investigate phase relationships between predator and prey. Some species were cyclic but no longer are. Marten ceased to be cyclic before 1920. Fisher, lynx, mink and wolverine continue to be cyclic. Fisher did not cycle during 1751 to 1847 but did from 1920 to 1969. A break in cyclicity is attributed to habitat disturbances and increasing trapping pressure. *See also Hewitt 1921, Cowan 1938, Butler 1953, Bulmer 1974.*

Buskirk, S. W. 1991. Habitat ecology and ecologists, what are we doing? Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

foraging, habitat use, rest sites

ABSTRACT: The genus Martes apparently evolved in forested habitats, and most of the living taxa are forest dwellers. Populations of fishers and American marten require landscapes that include and may be dominated by forests or woodlands. In the case of American marten the forest component typically includes or is dominated by late successional, mesophytic, coniferous types. The occurrence of seasonal snow cover is a strong correlate of the southern geographic limit of American martens. Fishers are also tied to coniferous forests, but show greater within-species variability in successional stage than do marten.

Fishers and American martens show seasonal variation in patterns of habitat use in most studies that allow such comparisons. Generally, both species use a wider range of cover types in summer than in winter. During winter, both species tend to prefer conifer-dominated over hardwood-dominated forests, and to prefer old conifer-dominated stands to young ones. Some recent burns with complex physical structure near the ground enable martens to use unforested habitats in winter. Differences in habitat use that are related to behavior type (travelling vs resting) are not consistent for American marten. Fishers appear to be more habitat-selective for resting than for foraging.

Several life needs have been invoked to explain associations with specific habitats of habitat features, especially with late successional forests. They include avoidance of predators, access to subnivean spaces for foraging, and availability of warm sites for resting in winter, especially as these factors relate to habitat structure.

Habitat studies of fishers have been fewer in number, but have covered a wider range of habitat variable (ANOVA, $df = 23$, $P < 0.0001$) than is the case for American martens. Studies of fishers allow greater comparisons between studies and areas. Habitat studies of marten and fisher should be directed toward understanding general principles, which will enable us to interpret differences of species, site, and season.

Butler, R. L. 1953. The nature of cycles in populations of Canadian mammals. Can. J. Zool. 31:242-262.

[1]Canada, population cycles, snowshoe hare, furbearers
1919-1951

Harvests of furbearers from 1915 were examined to determine whether peaks are cyclic, or arise by chance. Peaks in harvests did not occur randomly, and did not necessarily occur in the same year throughout Canada. Fisher was grouped with fox and lynx with respect to frequency of peak harvests. The "good years" for lynx, fox, fisher, coyote, and wolf, are closely connected to those for snowshoe hare. Fisher appeared to respond more slowly to the good years. This is attributed to delayed

implantation, an unalterable biological lag. *See also Hewitt 1921, Cowan 1938, Bulmer 1974, 1975.*

Carlson, B. L and S. W. Nielsen. 1985. Thyroid adenoma and ovarian luteinization in an aged fisher (Martes pennanti). J. Wildl. Dis. 21:320-324.

Carlson, B. L. and V. G. Sasseville. 1984. Dracunculus insignis in fishers (Martes pennanti) in New Hampshire. J. Amer. Vet. Med. Assoc. 185:1327.

Clem, M. K. 1977a. Food habits, weight changes, and habitat selection of fisher (Martes pennanti) during winter. M.Sc. Thesis, University of Guelph, Ontario, 49p.

[1]condition, diets, fat indices, harvest sex ratios, Ontario, weights
1972-73, 1973-74, 25 October - 28 February

Objectives were to estimate winter diets; examine diets with respect to sex, location, and time of capture; report on monthly changes of internal fat; examine harvest sex ratios; and estimate habitat use.

DATA were 324 carcasses trapped in the Algonquin, Parry Sound, and Bracebridge regions. Prey in stomachs and gastro-intestinal tracts were identified. The relative abundance and availability of prey were not determined. Mesenteric fat was selected as being the most representative of body fat. Empty stomachs, intestines, and mesenteric fat were wet-weighed. Habitat use was assessed by livetrapping, marking, and recapturing. Ten trails were followed over 2 winters.

DIETS: Major food items were snowshoe hare, muskrat, porcupine, small mammals and birds. Diets differed between 2 arbitrarily designated areas and between years, for both sexes. Porcupines were consumed predominately in November, snowshoe hares in December, and muskrats were consumed all winter. Differences between diets of males and females were few.

WEIGHTS AND FAT LEVELS: Carcass weights were lowest for both sexes in December, highest in February for males, and in November for females. The mean weights of intestinal tracts, stomachs and mesenteric fats were higher for males in all months. (*The amount of fat that can be maintained is a function of body weight. This result may be due to the larger size of male fishers*). Generally, mean weights were higher in November.

HARVEST SEX RATIOS in 1972-73 were not different from 1:1 but were biased to females in 1973-74. Females may be more susceptible to being trapped.

HABITAT USE: Fisher appeared to be foraging in areas where conifer cover types predominated. *However, traps were not placed in habitats in proportion to their relative availability and the utility of this analysis is limited. The author notes that time and financial constraints prohibited a proper assessment.*

Clem, M. K. 1977b. Interspecific relationship of fishers and martens in Ontario during winter. in Phillips, R.L. and C. Jonkel (eds.). 1977. Proceedings of the 1975 Predator Symposium. Montana Forest and Conservation Experimental Station, University of Montana, Missoula, p. 165-182.

[1]competition, condition, diets, fat indices, marten, Ontario
1973-74
Competitive interaction between fishers and marten may be important in controlling distributions and population levels. This hypothesis was investigated by comparing winter diets.

MATERIALS were 385 fisher, and 184 marten carcasses collected from trappers. Results for fisher are generally the same as those in Clem 1977a. For comparisons, 22 prey items were selected on the basis of dietary importance to both species. Abundance and availability of prey were not determined. Empty stomachs, intestinal tracts, and mesenteric fat were wet-weighed as an index to condition.

Fisher and marten diets did not overlap until December. Diets from December to the end of February were similar. Fishers ate larger prey than marten. Weight losses in female fishers during November may demonstrate dietary and physiological changes.

Coulter, M. W. 1960. The status and distribution of fisher in Maine. J. Mamm. 41:1-9.

[1]density, dispersal, distribution, Maine
A summary of the details of the increase of fisher in Maine.

In the 1800's fishers were present in Maine but were not abundant. In the 1900-1930's, high pelt prices promoted over-harvesting. In the mid 1930's, fisher were uncommon. A closed season was instituted in 1937. In 1949, wardens reported fishers as common or abundant; 10 years earlier, they were documented as rare or absent. Trapping was allowed in 1950. Increases originated from the Moosehead Plateau, an area with numerous mountains 1200-1500 m in elevation, lack of settlement, and a vast spruce-fir-northern hardwood forest. (Fishers were never extirpated from this region). After 1950, fisher continued to increase in numbers and disperse into other parts of Maine.

DISPERSAL was most rapid in hilly country, regardless of the forest cover present. Areas of low-lying forest containing a high proportion of bog or generally soggy area, even if densely forested, were not invaded rapidly. In 7 years, the fisher range increased from 33800 km^2 to 59800 km^2, an expansion of approximately 75%. The DENSITY of populations varies greatly. In good habitat, densities were estimated as 1 fisher per 10-12 km^2. Protection appears to be the most important factor responsible for the increase of fishers.

Coulter, M. W. 1966. Ecology and management of fishers in Maine. Ph.D. Thesis, State Univ., College of Forestry at Syracuse University, New York, 196p.

[1]age determination, density, diets, dispersal, forest cover, habitat, harvest sex ratios, harvests, Maine, management, morphology, pelts, predator-prey, porcupine, reproduction
1950-1960 (field), 1950-1963 (carcasses)
This seminal paper describes the first extensive study of fisher biology, through the use of snow tracking, an analysis of 376 carcasses, and observations of live and captive fishers.
1950-1963

DATA were collected from winter tracking (1950-1966), observations of penned

fishers (1963-1966) and 376 carcasses. The range of fishers in Maine doubled to approximately 65,000 km^2 over the duration of the study. Rates of dispersal were 8 km per year in northern Maine and 14 km per year in southern Maine. A broad river slowed penetration into one region. Densities were greater than 1/2.6 km^2 in some areas, but these were believed temporary. Fishers were solitary, primarily nocturnal and terrestrial during winter.

ADE DETERMINATION AND MORPHOLOGY: Unfused cranial sutures were characteristic of juveniles. The length of the saggital crest in females and the overhand of the crest in males distinguished juveniles from adults. Colour variations were apparent between age classes, sexes, and seasons but not between populations. Molting occurred in late summer. Males always had more fat in relation to body size than females.

REPRODUCTION: Parturition occurred from late February to 1 April. A female killed in southern Maine in mid January had 3 well developed embyros. Two females trapped in late March had recently bred. A female trapped on March 27 had not bred and displayed no signs of estrus. Kits were altricial and averaged 3 per female. Eyes of kits opened at 53 days. Nursing continued into the fourth month. Dispersal occurred before late November.

WINTER DIETS: Predominant foods in 242 gastro-intestinal tracts were snowshoe hare, porcupine, white-tailed deer (carrion), birds, shrews, mice, and sciurids. Fishers killed porcupines by attacks to the head region. Quills were present in body tissues of 127 of 365 carcasses. Although parasitism was frequent, diseases were uncommon. The fisher is a new host for Taenia sp. and Alaria sp.

HABITAT: Spruce-fir type forests (pole stage or older) were used more than available. However, fishers also lived in extensive hardwood stands where conifers were not abundant, particularly in southwestern Maine. Fishers avoided crossing fields or frozen lakes and highway right-of-ways. Resting sites (n=48) were often in brush piles, under logs, under the upturned roots of a windthrown tree, in tree dens, in a hollow log, and 1 was in a ground burrow.

HARVESTS: The harvest was biased to males when trapping pressure was light and to females when trapping pressure was high. Males were trapped more frequently in late winter, due to the increased activity of breeding.

Cunningham, J. D. 1959. The wolverine and fisher in the Yosemite region. J. Mamm. 40:614-615.

[1]California, distribution
Two sightings of fishers are reported.

Dalquest, W. W. 1948. Mammals of Washington. University of Kansas Publ., Museum of Nat. Hist. 2: (fisher) 187-189.

distribution (map), habitat, Washington

The fisher is rare in Washington and seems never to have been common. Distribution is probably confined to the Cascade and Olympic Mountains. A few may occur in northeastern Washington, the Blue Mountains and the Willapa Hills. Most trappers agree that fishers occupy lower elevations than do marten.

Davison, R. P. 1975. The efficiency of food utilization and energy requirements of captive female fishers. M.Sc. Thesis, University of New Hampshire, Concord N.H. 53p.

[1]deer, diets, energetics, snowshoe hare

Objectives were to evaluate the relative value of 4 diets: snowshoe hare, white-tailed deer meat and viscera, small mammals (meadow voles, short-tailed shrews, white-footed mice), and quails; and to estimate maintenance energy requirements.

STUDY ANIMALS were 4 captive females, 2 juveniles and 2 adults. Crude protein content was highest in snowshoe hare (72%) and lowest in quails (49%). Percent fat was highest in quails (39%), and lowest in snowshoe hare (3.7%). Body weight fluctuated widely and was not a sensitive index of growth or fattening. The efficiency of conversion of dietary nitrogen to body tissue was greater on the hare diet. The mean fasting heat production was 162 kcal / kg $W^{0.75}$ (for active fishers). The combination of age classes, small sample, and use of only female fishers preclude general conclusions.

Davison, R. P., M. W. Mautz, H. H. Hayes, J.B. Holter. 1978. The efficiency of food utilization and energy requirements of captive female fishers. J. Wildl. Manage. 42:811-821.

[1]**see Davison (1975).**

deVos, A. 1951. Overflow and dispersal of marten and fisher from wildlife refuges. J. Wildl. Manage. 15:164-175.

[1]dispersal, marten, Ontario (Chapleau Forest District), refuge

The importance of a wildlife refuge for the re-establishment of marten and fisher in a depleted area is investigated.

METHODS: Fur harvests from 1941-42 to 1949-50 were examined to determine the relative abundance of marten and fisher at increasing distances from wildlife refuges.

RESULTS: Fisher and marten were more abundant close to preserves. Establishment permitted dispersal into surrounding areas. Fisher colonized areas of the best habitats first: more mature forest, closer to climax stage, and a greater percentage in coniferous trees. The increases observed may have been due to a cyclic high. However, this explanation does not account for the overflow observed from the preserve and not from the residual pockets of fisher. A progressive decrease in abundance from the game preserve occurred for marten, but was less evident for fisher. However, pockets of fisher existed before the preserve was established.

deVos, A. 1951. Recent findings in fisher and marten ecology and management. Transactions, N. Am. Wildl. Conf. 16:498-507.

[1]diets, habitat use, harvests, harvest sex ratio, management, marten, movements, Ontario

1948-1951 (3 winters, 2 summers).

Results of a snow tracking study on fisher and marten.

MOVEMENTS of fisher were circuital and governed by the availability of food, topography and cover; food was the most important factor. Males had larger home ranges than females. Fisher are less arboreal than noted in the literature, but have a "liking" for walking on fallen logs.

DIETS were estimated from the contents of 32 stomachs. Major prey were snowshoe hare (31%), porcupine (20%), fish (11%), small mammals (6%), and birds (4%).

HABITAT: Mixed and pure stands of trembling aspen and paper birch were poor habitat, as were recently logged and burned-over areas. Forest cover was an important factor in habitat use. Later seral stages also provided more denning opportunities. The low abundance of small mammals and other prey in black spruce muskegs make these habitats unproductive. Fishers are better adapted to earlier successional stages than are marten.

HARVESTS: The sex ratio of fishers in the 1949-50 harvest of Ontario were slightly biased to females. The 1950-51 harvest had a slight bias to males.

deVos, A. 1952. Ecology and management of fisher and marten in Ontario. Ontario Dept. of Lands and Forests, Tech. Bull., Wildl. Ser. 1, 90p.

[1]age determination, arboreal activity, condition, diets, distribution, habitat use, harvests, harvest sex ratios, management, marten, movements, Ontario (Chapleau District), parasites, pelts, refuges, resting sites, review, snow cover, snow tracking
January 1948 - April 1952
Behaviour of fishers was determined from snow tracking and extensive information from trappers. Management guidelines were developed.
"This manuscript was presented in a more complete form as a Ph.D. thesis for the University of Wisconsin 1951".

DATA were collected by snow tracking and from interviews with trappers. Trappers reported that fishers tend to make circuital movements. These ranged from 13-32 km in diameter and 64-160 km in length. It was not possible to delineate home ranges. Movements appeared to be restricted by heavy snowfall. Fishers were solitary except for family groups and mating pairs in the spring. Arboreal activity was rarely noted and fishers are probably less arboreal than usually described. Fishers do not hesitate to swim when advantageous.

RESTING SITES; "The fisher is not particular in it requirements for the site of a den". Temporary resting sites were holes under large boulders, dens dug in the snow, hollow logs and brush piles. Two temporary resting sites were in deserted beaverhouses. If a large supply of food is nearby, such as an ungulate kill, a fisher may den up from several days to a few weeks. Fishers den up during heavy snowfall.

DIETS were described using 59 stomachs and gastro-intestinal tracts and 9 scats collected during 1933-1952. Predominant prey were snowshoe hare, porcupine, carrion (white-tailed deer and moose), small mammals and sciurids. The habit of feeding on carrion is well developed, especially where available. Carcasses (n=22) had little fat deposits but appeared to be in good to fair condition. Parasites were listed (*see Sprent 1952*). The utility of skull measurements for aging was investigated, however only a small sample of skulls was available and known age material was unavailable. Harvest sex ratios were biased to females.

HABITAT: Fishers have general habitat requirements, occurring in mixed, coniferous, and hardwood stands, in flat as well as in rocky country. Fishers were rarely seen in open, second growth stand and only occasionally in recently burnt-over areas. They were rare to absent in extensive even-aged stands of aspen-white birch. Recent burns and cedar swamps were visited, probably because of the occurrence of snowshoe hare. Fishers appear to be more adaptable to environmental changes than are marten. Fishers have disappeared from most of the settled portions of southern Ontario. They were relatively common in northern and central Ontario but population sizes have decreased. Contributing causes were overtrapping, the use of poison as a trapping method, hunting of females, and extensive habitat loss due to logging, fires, and settlement. The establishment of refuges is an effective method of increasing populations. Logging which provides for well-dispersed blocks of mature timber might result in a higher carrying capacity for fishers. Trappers may make brushpiles to increase den sites and provide cover.

Dick, T. A and R. D. Leonard. 1979. Helminth parasites of fisher, Martes pennanti (Erxleben), from Manitoba, Canada. J. Wildl. Dis. 15:409-412.

[1]Manitoba, parasites
Parasites of fisher, their distribution, prevalence, and intensity based on host age are described.

DATA were 157 fisher carcasses. Gastro-intestinal tracts, lungs, and hearts were examined. Helminths were recovered from 52 of 162 fisher. Only for T. sibirica were there sex differences (19 F, 6 M), but no age differences. Juveniles had higher prevalences of B. devosi and Physaloptera sp. than adults (36% vs 19%, 6% vs 3%, respectively). Prevalence varied among the 4 sample areas. Lungworms, kidney worms, and guinea worms were not detected.

Dick, T. A., B. Kingscote, M. A. Strickland and C. W. Douglas. 1986. Sylvatic trichinosis in Ontario, Canada. J. Wildl. Dis. 22:42-47.

[1]diseases, marten, Ontario, parasites
1972-1982, November - February
Trichinosis is a reportable zoonotic disease in Canada. The occurrence of larvae of Trichinella in selected wild mammals and the importance of these hosts in its transmission were determined.

Fisher and marten were the main hosts of Trichinella spiralis. Of 18 species, 83 of 1821 (5%) fisher and 68 of 1980 (3%) marten were infected with larvae. Larvae were absent from all other hosts, except for 1 of 12 mink. The prevalence of larvae increased with the age of fisher and marten. In juveniles, incidence increased with time and was highest in February. The main transmission route of sylvatic trichinosis in boreal regions of central Canada is through marten and fisher. Carrion likely plays a role in this transmission.

Dix, L. M. and M. A. Strickland. 1986. Sex and age-class determination for fisher using radiographs of canine teeth: a critique. J. Wildl. Manage. 50:275-276.

[1]age determination (technique), radiographs
A critique of the interpretation of Jenks et al. (1984) of width ratios in radiographs of canine teeth.

Jenks et al. (1984) misinterpreted their 99% confidence limits and wrongly concluded that fisher _ 3 years old could be aged from the width ratios of the pulp cavity in canines. Tolerance limits are the appropriate confidence interval, not confidence limits. With 95% tolerance limits, 3 year and older fishers could not be distinguished. Width ratios, did however, separate juveniles from adults _ 1 year old. (*see also Jenks et al. 1984, 1986*).

Dixon, J. 1925. A closed season needed for fisher, marten and wolverine in California. Calif. Fish and Game 11:23-25.

[1]California, harvests
1920-1924
Harvests of fisher in California have declined (a loss of 67% in the 5 year period). The corresponding large increase in pelt prices indicate demand is high and that populations are also declining. A 3 year closed season is recommended.

Dodds, D. G., and A. M. Martell. 1971. The recent status of the fisher, Martes pennanti pennanti (Erxleben), in Nova Scotia. Can. Field-Nat. 85:63-65.

Douglas, C. W., and M. A. Strickland 1987. Fisher. Chapt. 40, p. 511-529. in: M.Novak et al. (eds.). 1987. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, 1150p.

[1]activity, age determination, behaviour, blastocysts, breeding, condition, density, description, diets, distribution (map), fat indices, gestation, habitat use, harvests, home range, livetrapping, litter size, management, marten, morphology, mortality, natality, Ontario (Algonquin), parasites, parturition, pelts, population cycles, population models, primeness, re-establishment, reproduction, review, sex determination, skull, techniques
A comprehensive review of fisher distribution, life history, ecology, diets, behaviour, and management. Only results of Douglas and Strickland are included here. The data (including previously unpublished) are more than 6000 fisher carcasses trapped during 1972-1985.

MORPHOLOGY: Females usually have darker, silkier fur than males, and bring a higher price on the fur market. There is large intra-population variation in body size (lengths and weights). A mean ratio of pelted to whole carcasses ranged from 0.822 to 0.833 for all sex and age groups (n=161).

DISTRIBUTION: Fishers were re-established in the western part of Algonquin by transferring 97 fishers over 6 winters (1957-63) into prime habitat. The local population has increased and 300-400 are harvested annually.

REPRODUCTION: Males were spermatic by 12 months of age. Sperm were present during February and March in males of all ages, but only 8% (3 of 39) of males examined from November to January had sperm. Testes increased in weight over winter in all ages and testes of juveniles were adult size by March. Juvenile males, although spermatic, may not be effective breeders. The baculum increased in size and changed in shape with age. Young males may be less effective in inducing ovulation. Bacula of adults weighed more than those of juveniles during March and April.

None of the juvenile females (7-9 months old, n = 476) had corpora lutea. Developing follicles in ovaries indicated that ova would be released the next breeding season. Mean number of corpora lutea per pregnant female varied with age. Females aged 3.5-7.5 years had more corpora lutea (3.5-3.9). Counts may be lower in older females (>8 years, 3.4-3.6, n=10). Of adult females (n = 1173), a mean of 97% were pregnant yearly. From 1973-1975, the population was being heavily trapped and was declining, and 92% of adult females were pregnant. This may have been a result of a shortage of adult males in the population. The breeding season is from late March to early April. Date of parturition is from 27 February to 15 April, although exceptions may occur. Three fishers trapped in December had developed fetuses that would have been born before 15 January. Another female, trapped on 9 March, had unimplanted blastocysts. Sex ratios of birth (F:M) were 45:55, not different from 1:1.

MORTALITY: Fisher have few enemies besides humans. Of more than 6000 fishers, 2 were killed by dogs and 1 had a badly necrotized mandible. A skeleton of a 7.5 year old male had evidence of severe arthritis and bony overgrowths in the spine, joints, and jaw. Of 3464 fishers, 9% were pierced by porcupine quills, some internally. No significant damage, inflammation, or infection was apparent. Occasionally fishers are killed on highways. Intraspecific strife, assessed from scarring of pelts, occurred most frequently in juvenile males (163/307, 53%) and adult males (47/113, 42%). Frequencies in females were 16% (50/305) in juveniles, and 5% (7/153) in adults. Many internal and external parasites have been reported in fishers, but there is no evidence that they are significant mortality factors.

CONDITION: Over 90% of fishers had deposits of body fat, indicating they were in good condition. Adults had the least and males usually had more fat than females.

WINTER HABITAT USE was determined from questionnaires sent to trappers. Results (683 responses) were wetlands 23%, old mixed hardwood/conifer 21%, young mixed hardwood/conifer 21%, old hardwood forest 11%, old conifer forest 8%, young hardwood forest 8%, young conifer forest 6%, and other 2%. These results were similar to those reported for marten.

DENSITY: The 31,000 km^2 study area has supported a sustained annual harvest of approximately 1 fisher/25.9 km^2 for the past 5 years. This harvest is approximately 25% of the pretrapping population, indicating a fall density of approximately 1 fisher/6.5 km^2.

FISHER AND MARTEN: Harvest maps of Ontario suggest an inverse relationship in fisher and marten harvests. This may indicate a fisher-marten interaction or reflect different habitat requirements.

SEX AND AGE DETERMINATION: Males are longer and heavier than females, and adults are longer and heavier than juveniles, for both sexes. However, overlap precludes using length and weight for aging. Age cannot be determined from pelt size and there is overlap between sexes. Baculum weights between ages overlap and cannot be used to age adults. A baculum weight of <1.5 g differentiates juveniles (0.5 years) from adults, for fisher caught before January. Zygomatic width, skull length and weight (cleaned skulls) may be used to separate sexes. The saggital crest is large in adult male fishers. It begins to form in males by 9-10 months but does not overhand the supraoccipital bone as it does in adults. Any female that has a crest is an adult, but not all adult females have crests.

REGULATING HARVESTS: An indicator of trapping intensity is the ratio of juveniles : females _ 2.5 years. Heavy trapping will provide a sample skewed to adult females, because the more vulnerable males in the population have been trapped. Many jurisdictions use periodic season closures to regulate populations. Fishers are highly susceptible to overharvesting.

Douglas, C.W., and M.A. Strickland (eds). 1979 (ms). Transactions of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset Ont., October 21-23 1979, 139p.

age determination, age ratios, bacula, behaviour, density, delayed implantation, diseases, estrus, feeding, harvests, harvest rates, home range, Maine, management, Manitoba, marten, Massachusetts, Minnesota, morphology, mortality, movements, natality, New Hampshire, North Carolina, Nova Scotia, New York, Ontario, parasites, physiology, population cycles, population models, Quebec, refuges, reproduction, sex ratios, testes, Vermont, Wisconsin
Transcripts of discussions of the workshop and prepared submissions from managers and researchers, with an emphasis on current problems and management.

Eadie, W. R., and W. J. Hamilton Jr. 1958. Reproduction in the fisher in New York. New York Fish and Game J. 5:77-83.

Edwards, R. Y, and I. McT. Cowan. 1957. Fur production of the boreal forest region of British Columbia. J. Wildl. Manage. 21:257-267.

[1]British Columbia, density, distribution, furbearers, habitat, harvests
1929-1948 (harvests)
A succinct report of Edward's (1950) thesis.

Habitat productivities were calculated as the average area required to produce 1 pelt in 1 year. Seven areas of the Boreal Forest region were designated, the Yukon Forest, the Stikine Forest, the Liard Plain, the Nelson Forest, the Northern Peace Forest, the Peace Parklands, and the Southern Peace Forest. Fisher appeared to be absent from the Yukon and Stikine Forests and became progressively more abundant from north to south on the plains. In British Columbia, fishers are at the northern limit of their range. Productivities of forest areas were South Peace, 455 km^2/pelt, Liard Plain 676 km^2/pelt, Peace Parklands 858 km^2/pelt, North Peace 1170 km^2/pelt, and Nelson Forest 1726 km^2/pelt. The low productivity value for the Nelson Forest does not support Quick's (1953) designation of it as an area of fisher abundance. Fishers appear to favour areas of relatively dry, well-drained, semi-open mixed forest. The maintenance of fishers in the Peace Parklands may be due to invasion from adjacent regions.

Edwards, R. Y. 1950. Variations in the fur productivity of northern British Columbia. M.A. Thesis, University of British Columbia, 126p.

[1]British Columbia, density, distribution, furbearers, habitat, harvests
1929-1948 (harvests)
Yearly harvests of 155 traplines in Northern and Northeast British

Columbia were examined with the objective of predicting habitat productivities for furbearers.

Productivity was calculated as the area required to produce 1 pelt in 1 year. Seven forest sections based on physiography and vegetation were designated. Productivities ranged from no fishers in northern mountainous regions and 1 fisher/1727 km^2 in the Great Plains region of the northeast, to a high of 1 fisher/413 km^2 in the most southerly eastern forest section. Fishers are trapped in open, largely deciduous forests, and apparently are not as dependent on climax coniferous forests as are marten. Fishers are most successful in drier forests, or in transitional forests bordering dry areas. (*See also MacLeod 1950, Bandy 1952, Edwards and Cowan 1957*).

Enders, R. K. and O. P. Pearson. 1943. The blastocyst of fisher. Anatomical Record. 85(3):285-287.

[1]blastocyst, delayed implantation, reproduction
Confirmation of delayed implantation in fishers.

Six blastocysts were found in the reproductive tracts of 2 fishers, trapped during January and February. A female killed in March had one corpus luteum but no blastocysts.

Freel, M. 1991. A literature review of management of the marten and fisher on National Forests in California. USDA Forest Service Pacific Southwest Region 22pp

Gibilisco, C. J. 1991. Distributional dynamics of marten and fisher in North America. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

distribution, reestablishment

ABSTRACT: This paper is a summary of the present and historical distribution of marten (Martes americana) and fisher (M. pennanti) in North American, emphasizing the distributional changes that have occurred since Hagmeier's work in the mid 1950's. Information has been obtained through a survey of the literature, with more current data gathered through a survey and personal communications with marten/fisher managers and biologists across the continent.

The historical range of marten has been marked approximately by the 50° N latitude line, corresponding to the northern treeline and roughly following the boreal and montane forest southward. The fisher's historical distribution shares much overlap, although its northern limit is 10° south of that of the marten, and its distribution is much more restricted in the Rocky Mountains and extends farther south in the Appalachian Mountains.

Throughout the late 1800's and early 1900's, both fisher and marten numbers were drastically reduced across the continent, and they were eliminated throughout much of their former range. During this period, national and provincial parks, forest reserves, and extensive expanses of undisturbed habitat may have provided refuges for both species.

Regional habitat changes throughout the 1900's, coupled with closed trapping seasons, have resulted in range expansion of fisher throughout much of eastern North America. In contrast, in western North America, fisher have experienced range contractions in the midst of dramatic habitat changes, and their current status is in

question in the northwestern U.S. For marten, in most areas, trends are more variable. Many localized range extensions can be attributed primarily to reintroduction efforts, with the exceptions of a natural reinvasion of northeastern Minnesota and adjacent Ontario. There have been substantial range reductions in some places along the west coast, and marten have been reduced to remnant populations in Newfoundland and elsewhere. In yet other areas marten seem to be holding their own where habitat is adequate.

Goldman, E. A. 1935. New American mustelids of the genera Martes, Gulo, and Lutra. Proc. of the Biol. Soc. of Wash. 48:175-186.

[1]subspecies, taxonomy

The British Columbia fisher, Martes pennanti columbiana, is designated as a new subspecies (95 specimens examined). The locality of the type specimen is Stuart Lake, near the headwaters of the Fraser River. Distribution is the Rocky Mountain region from northern B.C., south to central Idaho, and east, mainly in southern Canada, grading to M. pennanti pennanti in Manitoba.

Graham, R. W. and M. A. Graham. 1991. Late Quaternary distribution of Martes in North America. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

distribution

ABSTRACT: During the late Quaternary, the distribution of both marten (Martes americana) and fisher (M. pennanti) extended much further south and to lower elevations than their current distributions. Climatic warming at the end of the Pleistocene caused both of these species to retreat further north and to higher altitudes in conjunction with their preferred vegetational habitats. However, these changes in distributions were not simple shifts in response to changing isotherms as indicated by the numerous extralimited Holocene records (10,000 years ago) of martens and fishers in the midwestern and southeastern United States.

Many of the Holocene records are from archaeological sites which must be interpreted with caution because human trading of skins and other parts of these animals may introduce bones into archaeological sites which were not within the ranges of the species at the time. Analysis of osteological elements represented at the archaeological sites can help differentiate between trade items and natural occurrences. Also, Holocene paleontological records can assist in eliminating cultural factors.

The extinct noble marten (M. nobilis), which may have been adapted to a wide spectrum of environments, apparently survived in the southwestern United States until about 3000 years ago. Modern distributions of Martes are not only the result of natural environmental changes but also the consequence of human impact in historic, and perhaps prehistoric, times. Analysis of the changing distributions of Martes with a Geographic Information System (GIS) and relational databases will facilitate interpretations of these past changes.

Grenfell, W. E. and M. Fasenfast. 1979. Winter food habits of fishers, Martes pennanti, in northwestern California. Calif. Fish and Game 65:186-189.

[1]diets, California
Dec 1977 - Feb 1978

Griffin, K.A. and F. K. Gilbert. 1991. Energetics of captive fishers. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

energetics

ABSTRACT: Basal metabolic and exercise metabolism rates for fisher (Martes pennanti) were determined during winter ambient temperatures, using an open flow system to measure oxygen consumption (VO_2). Exercise metabolism was determined by running fishers at various speeds on a treadmill while measuring VO_2. Preliminary analyses suggest that VO_2 decreases as speed increases which appears to be contrary to other studies. This may be due to increased efficiency of oxygen utilization of different gaits (i.e., walk vs. half-bound or bound) and/or may be related to thermoregulation costs as ambient temperatures tended to be lower for the faster speeds. Fishers were video taped while running to analyze gait with VO_2.

Basal metabolic rates (BMR) were determined in the morning and evening. A t-test on preliminary data suggests a significant difference between morning (0.587 ml/g h) VO_2 values ($t = 2.776$; $P = 0.05$). Temperatures were also significantly different during the morning (12°C) and evening (-0.1°C) experimental BMR's ($t = 9.008$; $P = 0.05$). The higher VO_2 values indicate the temperature may have exceeded the upper critical temperature. The BMR values (based on evening data) are higher than expected based on Kleiber and Iverson equations.

Heart rate as a correlate, and hence an indicator, of energy metabolism was assessed by implanting heart rate transmitters and monitoring heart rate while VO_2 measurements were made.

Grinnell, J., J. S. Dixon and L. M. Linsdale. 1937. Fur-bearing mammals of California: Their natural history, systematic status and relations to man. Vol I. University of Calif. Press, Berkeley. p. 211-230.

[1]California, density, diets, distribution, habitat use, management, mortality, reproduction, subspecies, taxonomy
An extensive review of the biology of fishers in California.

Stomach contents from 8 fishers were identified. Frequently occurring foods were false truffles (4), small mammals (deer mouse, Western harvest mouse, broad-handed mole) (4), black-tailed deer (2), gray squirrel (1), brush rabbit (1), and bovine (1). Although no porcupine occurred in stomachs, live captured fishers reportedly had quills in their hides.

TAXONOMY: Names of fisher, description, variations in colour, measurements and weights, and a description of the skull are provided. The fisher skull alters with age; the saggital crest increases in size, the zygomatic arches bow outward, and the constriction of the brain case behind the postorbital processes narrows. In a first re-examination, the designation of the race Martes pennanti pacifica (Rhoads 1898) is not supported. Much variation occurs in pelt colour. The propensity of fisher to wander permits extensive cross-breeding.

DISTRIBUTION: Fishers occur in the northwestern part of the State, but rarely in the immediate coastal region (redwood belt). They occur at middle elevations, 600-

1500 m in the north, and 1200-2400 m in the Mt. Whitney area. Some individuals reach 3270 m in summer. As a rule, however, the fisher in California is an inhabitant of the middle forest belt, at elevations of 1050-2250 m. Seasonal altitudinal shifts occur.

REPRODUCTION: Fisher chose cavities near the tops of large trees, or in hollow logs on the ground, for natal dens. From 2 to 4 young are born, on approximately 1 May. One litter of 3 was found in a den hidden in the crevices of a rock face.

DIETS: From stomach contents and observations, a large part of fisher diet consists of rodents, including porcupines, marmots, mountain beavers, gray squirrels, chickarees, wood rats, chipmunks, and mice. Fishers probably prey on grouse. Occasionally, they resort to vegetable food.

MORTALITY: Two fishers were killed by mountain lions.

DENSITY & MANAGEMENT: Fisher are nowhere abundant. It is doubtful if densities reach 1 fisher / 260 km^2. The decline in populations is due to their solitary nature and need for large home ranges. Suitable habitats are limited and are being reduced by logging. The commercial value of the pelt and rarity of the fisher make it a desired commodity. Closed seasons and the establishment of refuges are recommended.

Although records are unavailable, historical reports indicate that fishers occurred in the state. Proof is a fisher mandible, dated to 2000 B.C. - 1000 B.C., and found at an Indian site.

Hagmeier, E. M. 1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70:149-168.

[1]Canada, distribution (map), United States
Distributions were determined by a survey of the literature and an examination of museum records. Results are on a state and province basis. Only Canadian distributions and those of adjacent states are summarized here.

The northern limit of fisher is 10° south that of marten. While fishers extend as far south as marten in the Pacific mountains, their range is more restricted in the Rocky Mountains and more extended in the eastern U.S. Fisher are absent from the coastal islands.

<u>ALASKA</u>: no records.
<u>YUKON</u>: occur rarely in southeast Yukon.
<u>BRITISH COLUMBIA</u>: common in forested habitats. It occurs in the following biotic areas: Coast Forest (MacLeod 1950), Subalpine Forest (Bandy 1952), Cariboo Parklands (Webb 1953), Northern Columbia and dry Forests (east to Alberta) (Bandy 1952), and Boreal Forest (Rand 1944, Edwards 1950, Quick 1953). Fishers do not occur in the Parklands east of Fort Nelson.
<u>WASHINGTON</u>: the Olympic and Coast Mountains, absent in the Puget Lowland, present in Cascade Mountains.
<u>OREGON</u>: the Coast Mountains, and the Blue Mountains of the northeast.
<u>CALIFORNIA</u>: the mountainous parts of the state.
<u>MANITOBA</u>: chiefly between the Ontario border and Lake Winnipegosis, with a few further north along the Churchill River.

ONTARIO: formerly present throughout all of the province except the Hudson Bay lowlands. The southern range is now the French and Mattawa Rivers, and Algonquin Park.
QUEBEC: known only south of a line connecting the southern end of James Bay, Lake Mistassini and Mingan.
ALBERTA: all of forested Alberta.
NORTHWEST TERRITORIES: from Mackenzie District only.
NEW BRUNSWICK: restricted to central and northern parts of province.
MAINE: in all but the southern part of the state.
NOVA SCOTIA: No record of indigenous fisher since 1940. Several were introduced during late 1940's in the southwest part of the province.
NEWFOUNDLAND: no records.
PRINCE EDWARD ISLAND: no records.

Hagmeier, E. M. 1959. A re-evaluation of the subspecies of fisher. Can. Field-Nat. 73:185-197.

[1]taxonomy, subspecies
Martes pennanti is currently divided into 3 subspecies:
M. p. columbia was designated by Goldman (1935), a British Columbia subspecies; M. p. pacifica was designated by Rhoads (1898), a west coast subspecies; M. p. pennanti (Erxleben 1777) is an eastern variety, said by Goldman (1935) to occur no further west than the Manitoba - Ontario border.

DATA were 321 fishers captured over 3 seasons (summer, winter, moulting), classified by age class (juvenile, adult), and by sex. Subspecies had approximately equal sample sizes. Three external measurements and 14 cranial measurements were taken.

RESULTS: Geographic variation in skull characteristics was slight and the named subspecies are "lightly characterized". Based on the available material, subspecific designations in fisher are unwarranted.

Hall, E. R. 1942. Gestation period of the fisher with recommendations for the animal's protection in California. Calif. Fish and Game 28:143-147.

[1]breeding, British Columbia, California, gestation, litter size, parturition, reproduction, sex ratio
Information on reproduction of fishers on fur farms.

The fisher is rare in California. Despite Dixon's (1925) recommendation, a closed season was not implemented. Fisher have a low reproductive potential, females have one litter per year and litters are small. Fishers are important because they prey effectively on porcupine. Data were from records of fur farmers in British Columbia (128 - 160 km north of Kamloops). Matings occurred from 5 - 27 April, (mean = April 12, n = 26), gestation length was 338-358 days (mean = 352, n = 15), parturition occurred from March 23 to April 7 (mean = March 31, n = 22). Of 26 litters, the mean was 2.7, range 1 to 4. The sex ratio in 13 litters was 13 males, 20 females. Fisher mated approximately 10 days after giving birth.

Hall, E. R. 1981. The mammals of North America. Vol. II. John Wiley and Sons, New York, N.Y. (fisher) p. 985-987.

Hamilton, W. J. Jr. and A. H. Cook. 1955. The biology and management of the fisher in New York. New York Fish and Game J. 2:13-35.

[1]diets, distribution (map), density, harvests, home ranges, management, morphology, New York, reproduction (techniques), morphology, parasites, pelted:live weight ratio, sex ratios
1949-1953
Reproduction and diets were determined from trapped fishers.

The fisher has increased in the Adirondack Mountains region. Density estimates range from 1 fisher / 0.6 km^2 to 1 / 10 km^2. Fishers use home ranges approximately 26 km^2 in size. Males range more than females. Fishers are active both day and night. Trapped specimens ($n = 69$) were examined. Harvests were biased to females. Sex-specific harvesting may have contributed to the decline in population size. *Measurements and weights by sex, but not age, were provided.* For 6 fishers (3 M, 3 F), skinned weights averaged 80% of live weights. Diets were estimated using 60 stomach and gastro-intestinal tracts of late fall and early winter fishers. Main foods were deer (carrion, 18%), red squirrel (17%), red-backed vole (17%), shrews (13%), snowshoe hare (13%), porcupine (8%), and deer mice (5%). Birds (grouse, jays) comprised 12%. A technique of syringing uterine horns for blastocysts is described. Endoparasites were identified.

Heinemeyer, K. S. 1993. Temporal dynamics in the movements, habitat use, activity, and spacing of reintroduced fishers in northwestern Montana. M. Sc. Thesis, Univ. of Montana, Missoula 154 pp.

activity, behavior, colonization, competition, dispersal, energetics, habitat use, home range use, immobilization, livetrapping, management, Montana, mortality, movements, radiotelemetry, reestablishment, reintroduction, spatial patterns, thesis
Objectives were to describe the seasonal movements, activity, and habitat use of fishers reintroduced into northwestern Montana, with emphasis on examining the colonization ecology to gain insights for future reintroductions and conservation (also see Roy 1991).

ABSTRACT: In the final 2 years of a 4 year project to reintroduce fishers (Martes pennanti) to the Cabinet Mountains of Montana, I translocated 78 fishers (1.0:1.3 M:F; 33 were juveniles) from Wisconsin in 1990 -- 1991. Radiotags were placed on 25 animals in October 1990 to allow monitoring of movements, activity, habitat use, and fates through August 1991. Six animals were implanted with intraperitoneal transmitters, and 19 animals were radio-collared. Half the radiotagged animals were soft-released, with the remaining hard-released. Ground triangulation, aerial locations, and 24-hour remote monitoring revealed activity, movements, habitat use, and homerange establishment. Seasonal and permanent homerange and core activity areas (90% and 50% utilization volumes, respectively) were calculated with adaptive kernel analysis. Habitat selection, based on planimetric and hydrographic variables, was estimated using a nonmapping technique on a Geographic Information System.

During the 2-week post-releases period, soft- and hard-released fishers did not differ in movement rates ($p = 0.10$), activity levels ($p=0.89$), or mortality rates. Twenty-four fishers remained in the general release area, while 6 dispersed 9.4 -- 18.0 km. Of the total mortalities ($n=14$), seven were from predation within the first 2 months of release. Most animals stabilized through winter; 9 females and 5 males maintained winter homeranges. Habitat selection during the winter was minimal:

high activity levels, low movement rates, and a shift to nocturnal activity may indicate that harsh environmental conditions limited movements of the fishers. During the breeding season, fishers increased movement rates, and used low elevation habitats close to water, with flat or shallow slopes. Adult males increased movement rates, and the single adult male homerange increased from 3.6 to 99.3 km^2. Some females shifted core activity areas, resulting in overlap with the adult male and with each other. Juvenile males did not appear to respond to breeding season. After breeding season, females again shifted core areas to re-establish intrasexually exclusive areas. Nine animals (2 males and 7 females, including 2 from a prior release) established permanent homeranges. The fishers settled in low elevation, mesic habitats, in proximity to 2 prior residents; these prior residents may have served as indicators of habitat quality.

Montana females maintained small homeranges compared to standardized estimates for Idaho animals, possibly due to varying habitat quality or intrasexual competition; alternatively, this may be related to the colonization process. Although mortality removed 14 of the 25 animals from the population, higher settlement rates were seen in this study as compared to the first 2 years of translocations (Roy 1991). This is discussed in light of settlement and colonization processes, and implications for future reintroductions. The reintroduction process is examined at several scales, from animal husbandry to metapopulation dynamics.

Hodgson, R.G. 1937. Fisher farming. Fur Trade J. of Canada, Toronto 104p.

Holmes, T. 1991. Sexual dimorphism in North American Martes: Morphological answers to ecological questions. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

morphology, sexual dimorphism, systematics

ASTRACT: A phylogenetic analysis of the Mustelidae supports the hypothesis of a monophyletic Mustelinae as the sister taxon of the Melinae. Within the Mustelinae the analysis reveals two clades. One clade includes the monophyletic Martes as sister to Eira, Galictis, and Luncodon. Gulo is the primitive sister to these four genera and not closely allied to Mellivora as has been suggested.

An analysis of shapes and proportions of fore- and hindlimb elements in North American mustelids suggests that Martes americana is more specialized for arboreal life than M. pennanti. Ratios of condylobasal lengths and limb measures in males and females of a musteline species are not the same. Males have heads that are smaller relative to their body size than do females. This observation seems to refute the argument that sexual size dimorphism in mustelines is a resource partitioning phenomenon since the heads, which might be regarded as trophic structures, are closer to being the same size than are the bodies. Thirteen measures of cranial and dental structures were used to generate sexual dimorphism indices. These indices in Martes are more homogeneous than in Mustela; however, they do exhibit a pattern similar to Mustela and differ significantly from one structure to another. The indices were examined for a pattern of variation in sexual dimorphism consistent with the predictions of resource partitioning hypothesis. The hypothesis was refuted for the 3 species of North American weasels. The 3 ferret species, subgenus Putorius, display a pattern of variation in sexual dimorphism consonant with a resource partitioning hypothesis. North American Martes show no evidence that either species adjusts levels of sexual dimorphism due to the presence or absence of weasel species. Furthermore, comparisons of levels of sexual dimorphism in populations of Martes americana which are sympatric or allopatric with M. pennanti do not support a

resource partitioning hypothesis. The pattern of sexual dimorphism indices, taken as a whole, support the conclusion that while there is resource partitioning along a size gradient within populations of North American mustelines, this partitioning is best regarded as a result of, not a force driving, sexual size dimorphism.

Ingles, L. G. 1965. Mammals of the Pacific States. Stanford University Press, California. (fisher) p. 363, 371-372.

[1]California, distribution (map), Oregon, reintroduction, review, Washington
A review of fisher distribution and biology.

Fisher are rare in the Pacific States. They occupy the more unsettled areas in forests, lower in elevation than those occupied by marten and wolverine. A map of distribution indicates fisher occupy coastal regions in all 3 states, but primarily in Washington and Oregon. Oregon reintroduced fishers in 1961, for porcupine control.

Ingram, R. 1973 (ms). Wolverine, fisher, and marten in central Oregon. Oregon State Game Commission, Central Region Administrative Report No. 73-2, 41p.

[1]distribution (map), habitat, management, Oregon
Information on wolverine, fisher, and marten in Central Oregon was gathered through literature reviews and trapper interviews.

"Logging and burning of forests have been particularly detrimental to marten and fisher populations. Removal of overstory and ground cover has adversely affected the food supply, cover and denning possibilities...The fisher population is excellent in the Northeastern United States and low in the Western states.". Local trappers indicated that the fisher population in Central Oregon was very low. Management is limited to protection of habitat. Limiting the impacts of logging is a necessity.

Irvine, G. W., L. T. Magnus and B. J. Bradle. 1964. The restocking of fishers in Lakes States forests. Trans. N. Am. Wildl. Natural Resources Conf. 29:307-315.

[1]dispersal, livetrapping, Michigan, movements, porcupine, re-establishment, techniques, Wisconsin
The restoration of fisher in northern Wisconsin

Fisher vanished in Wisconsin during 1900 - 1920. Contributing factors were logging, burning, and over-harvesting. From 1956 to 1963, 121 fisher (78 M, 41 F) were released in Wisconsin and Michigan forests. Logistics of the transplantation program are discussed (cooperating agencies, livetrapping, holding and shipping, handling and release, legal protection, appraisal of results). Most successful trapping occurred in March. Dispersals from release points were 48 km (21 fishers, no sex/age given), and 64 - 104 km (6 males). About 50% of the other observations have been within 16 km of a release point, and over 90% have been within 48 km.

Jenks, J. A, A. G. Clark, and R. T. Bowyer. 1986. Sex and age determination for fisher using radiographs of canine teeth: a response. J. Wildl. Manage. 50:277-278.

[1]age determination, radiographs
The response to Dix and Strickland's criticisms of Jenks et al. 1984.

Jenks, J. A., R. T. Bowyer, and A. G. Clark. 1984. Sex and age class determination for fisher using radiographs of canine teeth. J. Wildl. Manage. 48:626-628.

[1]age determination, Maine, radiographs
The use of measurements from radiographs of canine teeth to separate sex and age-classes of fishers was investigated.

Data were radiographs of 180 lower canines from fishers in New York. Length of canine tooth distinguished sexes. The width ratio (pulp cavity width : total width) was the most reliable for age determination. Four age classes were distinguished, 0, 1, 2 and ≥3 years (*see also Dix and Strickland 1986, Jenks et al. 1986*).

Johnson, S. A. 1984. Home range, movements, and habitat use of fishers in Wisconsin. M.Sc. Thesis, University of Wisconsin, Stevens Point. 78p.

[1]activity, habitat use, home range, movements, Wisconsin (northern)
Aug 1981 - Aug 1982
A one year study using radio-telemetry and tracking. The thesis is presented in 3 manuscripts written for journal submission.

HOME RANGES, OVERLAP, AND SELECTION OF ELEVATIONS: Juveniles were considered as ≤ 22 months in age and adults, or breeders as > 22 months. Sixteen fishers were trapped (7 M, 9 F). Home ranges were determined for 12 fishers (4 M, 8 F). Male 100% home ranges ranged from 15.2 (68 locations) to 75.2 km^2 (79 locs.), and females from 1.9 (11 locs.)to 14.3 km^2 (193 locs.). Sizes of 100% home ranges may be biased because 32% of locations were obtained during March and April. Breeding movements influenced home range size. Monthly home ranges (February - May, November, December) were determined. Overlap in yearly home ranges was observed between and within sexes. However, monthly home ranges overlapped only for March, in 2 instances involving females.

FISHER MOVEMENTS AND TRACK CENSUS: Activity was determined by noting on which locations fishers were active, and by recording activity during the 24 hour day. Two daily activity peaks were recorded, between 0400 - 0759 hours, and 1900 - 2359 hours. Adult males moved more than all other age classes. Little differences occurred between monthly movements of sexes except during the breeding season (March - May). Females raising kits had restricted mobility. Movements were less in January, likely because of cold temperatures and deep snow.

HABITAT USE. Three habitat types were used most often in all seasons, edges, upland northern hardwoods, and mixed swamp conifer - hardwood. Habitats with little or no forest cover were used most often in summer. Monotypic forests with year round forest cover were not used often, probably because of the lack of structural diversity, and lack of prey diversity.

Johnson, W. A. and A. W. Todd. 1985. Fisher, Martes pennanti, behaviour in proximity to human activity. Can. Field-Nat. 99:367-369.

[1]activity, Alberta.
Observations of wild fishers (n=3) near roads and farmlands.

Jones, J. L and E. O. Garton, 1994. Selection of successional stages by fishers in north-central Idaho.Pages 377-387 in Buskirk, S.W., A.S. Harestad, M.G. Raphael, and

R.A. Powell (eds.) Martens, Sables, and Fishers: Biology and Conservation. Cornell University Press.

Based on thesis work (see Jones 1991)

Jones, J. L. 1990. A letter to the USFWS dated 9 August 1990

Jones, J. L. 1991. Habitat use of fisher in northcentral Idaho. M. Sc. Thesis, Univ. of Idaho, Moscow. 147pp.

deer, density, diets, dispersal, habitat use, home range use, Idaho, management, mortality, movements, natality, radiotelemetry, reproduction, resting sites, snowshoe hare, thesis
The most intensive habitat use study conducted in the western United States or Canada.

ABSTRACT: I studied habitat use, movements, and diets of radio-collared fishers (Martes pennanti) in northcentral Idaho from 1985-1988. Mature and old-growth forests were preferred during summer, whereas young and old-growth forests were selected during winter. A seasonal shift in habitat use was also apparent when forest structure and composition of overstory tree species at summer and winter locations were compared. A broader range of habitats was used for hunting relative to resting activities. During summer, mature or old-growth forests occupied 92% and 74% of resting and hunting sites, respectively. Fewer differences between resting and hunting observations were evident in winter. Fishers had a strong affinity for forested riparian habitats during summer and winter; stream courses also appeared to be used for travel. Male fishers moved more extensively than females; long distance movements of males frequently coincided with the breeding season. Median year-long home-range sizes were 82.6 km2 and 40.8 km2 for males and females, respectively (range = 28.8-119.5 and 6.0-75.4 km2, respectively); the medians were not statistically different ($U = 19$, $P = 0.20$). Snowshoe hares (Lepus americanus), voles (Clethrionomys gapperi and Microtus spp.), red squirrels (Tamiasciurus hudsonicus), and carrion were the most frequent items in the diet. Median counts of corpora lutea, blastocysts, and placental scars from 5 fishers were 2, 3, and 1.5, respectively (range = 1-3, 2-3, and 0-3, respectively). Longer timber harvest rotations may be required to maintain a viable population of fishers if even-aged management is pursued. However, uneven-aged timber management would likely maintain fisher habitat potential.

Kebbe, C. F. 1961. Return of the fisher. Oregon State Game Commission, Bulletin 16:3-7.

[1]habitat, Oregon, popular account, reintroduction,

In 1961, 24 fishers from British Columbia were introduced into Oregon. A general discussion of habitat use, reproduction, and hunting behaviour is provided.

Kelly, G. M. 1977. Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas. Ph.D. Thesis, University of Massachusetts, Amherst. 778p.

[1]activity, age determination (techaiques), blastocysts, densities, diets, forest cover, habitat use, harvests, harvest age ratio, harvest sex ratio, home range, livetrapping,

management, measurements, movements, natality, New Hampshire, predator-prey, reproduction, weights

Fishers were followed using radio-telemetry from Oct 1973 to Feb 1976, and carcasses were collected during 1973-74 and 1974-75. Objectives were to determine home ranges, movements, and habitat selection throughout the year; to investigate winter diets; and to develop an aging technique.

HOME RANGES: The study area (113 km^2) was in a non-trapped region. Over 3 years, 20 different fishers (6 F, 14 M) were captured. Because of small samples, ages were lumped for analyses. Mean number of corpora lutea in a sample of 12 trapped females (1973-1976) was 3.67. Yearly home ranges were determined for 11 fishers, using a mean number of 25.6 locations (7-70), occurring over a mean of 90.7 days (14-310). Mean adult home ranges were 19.7 +/- 17.5 km^2 (n=3) for males, and 15.1 +/- 3.7 km^2 (n=2) for females. Mean juvenile home ranges were 25.6 +/- 16.6 km^2 (n=3) for males and 15.1 +/- 5.9 km^2 (n=3) for females. No fishers had an exclusive yearly home range. All sex/age classes overlapped. (Data was unavailable for overlap between adult females).

MONTHLY HOME RANGES (n=24) were determined for 9 individuals (January, May to September), using a mean of 11.0 (5-24) locations collected over a mean of 20.7 (13-30) days. All monthly ranges overlapped among sexes and ages except for the ranges of an adult female and a subadult male during August and September. Movements were greatest for adult males, followed by subadult males. Movements increased during May, possibly influenced by the eruption of deciduous forest cover. A wide river was a barrier to fisher movement, possibly because of difficulty in crossing during summer, and lack of overhead cover during winter. Most locations were obtained between 0700 and 1459 hours. Fishers were active on 74% of locations. Activity increased with the proximity to sunrise and sunset, regardless of the time of year

HABITAT USE: Fishers used elevations of 329-607 m more than higher elevations. Females used higher elevations (556 +/- 82 m) than males (505 +/- 121 m). No seasonal differences in use of elevations were noted. Wetland associated forest types (riparian or low lying areas) and mixed softwood-hardwood types were used in greater proportion than available, and hardwood types less, by both sexes. Clearcut forest types (characterized by high stem densities of pioneer species such as cherry, aspen, and paper birch; and crown closures of approximately 100%) were used less than available in winter. These differences were apparent for females only in winter, and only in summer for males. Analysis for habitat selection of males in winter was not possible. Edge habitats were used more than expected in winter by both sexes.

DIETS: Major prey items (>10% frequency) in 30 stomachs were mice, bait, flesh and bone, and sciurids. Porcupine was not found in stomachs but occurred in live fishers and on carcasses (13 of 89); only one was a female. Prey abundance was determined by small mammal trapping. Wetland and softwood-hardwood forest types were above average in small mammal diversity. Hardwood forests had below average diversity. Clearcuts had above average diversity but were used less in winter, likely because of the lack of cover and greater snow depth. Wetland habitats are often associated with and are best created through the activity of beavers. Promotion of beaver colonies would aid fishers.

AGING: The use of cementum annuli as a technique for determining age classes of

fishers was examined. Cementum annuli appeared to be deposited in spring, during May or June. The number of annuli corresponded with ages determined using previously established reproductive and morphological criteria.

Kerns, S. J. and S. L. Criss. 1991. Fisher and marten presence in the managed timber stands of northern California. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

habitat use

ABSTRACT: Presently, little is known of the current status of fisher (Martes pennanti) and marten (Martes americana) in California forest lands since the curtailment of trapping of the two species in the decade following World War II. During the spring and summer of 1990, 26,000 ha of private commercial timberlands were surveyed for the presence of these furbearers. Fifty-six baited track stations were placed within 6 separate timber tracts located in 3 interior northern California counties. Seventeen track stations were placed within 3 coastal old-growth redwood timber tracts. In the interior, marten were detected at 34% of the stations and fisher at 13% of the stations. No marten or fisher were detected in the coastal redwood. Habitat components of each tract were compared. Marten were associated with the higher elevation true fir zone while no habitat association of the fisher can be made at this time. Furbearer detection methods were tested and refined during these surveys. A literature review was conducted to assess the current state of management knowledge of California fisher and marten populations. The need for a cooperative pilot research study to investigate fisher and marten utilization of managed timberlands was identified. This study is now in progress.

Krohn, W. B., S. M. Arthur, and T. F. Paragi. 1991. Mortality and vulnerability of a heavily trapped fisher population. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

harvest, mortality

ABSTRACT: We estimated nontrapping and trapping mortalities, and differential vulnerability, of 76 radio-collared fishers (Martes pennanti) in southcentral Maine, 1984-1989. Fur trapping ($n = 40$) and shooting (illegal, 3) accounted for 86% of 50 deaths. Other mortality causes included vehicle collisions (2), collar entanglement (1), unknown human cause (1), choked on food (1), infection (1), and coyote (Canis latrans) predation (1). Mean mortality during the nontrapping part of the year did not differ between juvenile females and juvenile males ($z = 0.16$; $P = 0.87$) (pooled rate = 0.28; 95% CL = 0.0, 0.47). Similarly, nontrapping mortality of adults did differ by sex ($z = 0.55$, $P = 0.58$) (pooled rate = 0.11; 0.01, 0.21). Mean mortality rates during the late October - early December (mean = 39 days) trapping season did not differ ($P > 0.05$) between juvenile males and females (pooled rate = 0.62; 0.43 - 0.75). The trapping mortality rate of adult females (0.21; 0.3 - 0.36) was lower ($P < 0.05$) than for adult males (0.42; 0.22 - 0.57), which was lower ($P < 0.05$) than the rates for juveniles. Mean mortality rates from trapping indicate that adult females were approximately 50% as likely to be trapped as adult males and 34% as likely as juveniles. Differential susceptibility to fur trapping suggests that changes in ratios of juveniles/females ≥2 years old may indicate the intensity of harvest, but caution is warranted in interpreting these ratios.

Kuehn, D. W. 1985. Calculating whole-body weights of fishers from skinned weights. Wildl. Soc. Bull. 13:176-177.

[1]Minnesota, morphology, weights
Nov 1982 - Jan 1983
The relationship between skinned and whole weights of fisher was determined.

Data were from 37 males and 14 females. Male fishers had a mean skinned to whole weight ratio of 0.775, and females, 0.811 (significantly different). Ratios did not differ among age classes within sexes.

Kuehn, D. W. 1989. Winter foods of fishers during a snowshoe hare decline. J. Wildl. Manage. 53(3):688-692.

diets, Minnesota
Diets of fishers in Minnesota were studied during 8 winters during a snowshoe hare decline.

ABSTRACT: I studied the diets of fishers (Martes pennanti) in Minnesota during 8 winters when the snowshoe hare (Lepus americanus) population declined. Fishers consumed less hare as the hare population declined, but fisher fat deposits and reproduction did not decrease. Fisher numbers in Minnesota are unlikely to track hare cycles and further restrictions on trapping may not be necessary to counteract effects of the hare decline.

Kuehn, D. W. and W. E. Berg. 1981. Use of radiographs to identify age-classes of fisher. J. Wildl. Manage. 45:1009-1010.

[1]age determination (techniques), radiographs
The utility of radiographs of fisher canines in distinguishing juveniles from adults was assessed.

Classification of adult or juvenile by degree of pulp cavity closure generally agreed with results using length of saggital crest. Results were verified with cementum analysis. Within the December - January trapping season, the use of radiographs is a relatively quick and inexpensive method of separating juveniles from adults.

Kuehn, D. W. and W.E. Berg. 1979 (ms). Fisher in Minnesota. in Douglas, C.W., and M.A. Strickland (eds). Transactions of fisher workshop held at Leslie M. Frost Natural Resources Centre, Dorset Ont., October 21-23 1979, p. 118-120.

[1]1977-78, 1978-79
harvest age ratios, diets, fat indices, harvests, Minnesota, natality, trapping seasons, weights
A summary of carcass results and current management.

Trapping for fisher was closed in 1931 and re-opened in 1977. Seasons are 1 December - January 31, with a limit of 3 fisher per trapper. Registration of pelts is mandatory. A total of 1218 carcasses over the 2 seasons were examined. Diets were determined from 393 stomachs. Major prey were snowshoe hare (36% each winter), white tailed-deer (19%, 31%, respectively), and mice (14%, 4%). The increase in deer consumption the second season reflects an increased deer mortality and a decrease in the availability of other foods. Porcupine occurrence was rare. A total of 1159 carcasses were aged and age ratios are presented. Pelted weights averaged 3.5

kg and 2.0 kg, respectively, for adult and juvenile males, and 1.7 kg and 1.6 kg for adult and juvenile females. Body fat indices were greatest for juveniles, and least for adult females. Of all adult females (>1 year), 82% were reproductive, averaging 2.1 corpora lutea.

Laberee, E.E. 1941. Breeding and reproduction in fur bearing animals. Fur trade Journal of Canada. 166p.

Leach, D and A. I. Dagg. 1976. The morphology of the femur in marten and fisher. Can. J. Zool. 54:559-565.

Leach, D and V. S. de Kleer. 1978. The descriptive and comparative post cranial osteology of marten (Martes americana Turton) and fisher (Martes pennanti Erxleben): The axial skeleton. Can. J. Zool. 56:1180-1191.

Leach, D, B. K. Hall and A. I. Dagg. 1982. Aging marten and fisher by development of the suprafabellar tubercle. J. Wildl. Manage. 46:246-247.

[1]age determination, marten, Ontario, osteology
Nov 1973- Feb 1974
The suprafebellar tubercle is located above the lateral fabellae of the femur.

DATA were femurs of 128 marten and 351 fisher. The percentage of adult and juveniles that did or did not possess a suprafabellar tubercle were determined. The method is reliable for distinguishing juvenile from adult males, in either species, but is not accurate for females.

Leach, D. 1975. The descriptive and comparative post-cranial osteology of marten (Martes americana Turton) and fisher (Martes pennanti Erxleben). M.Sc. Thesis, University of Guelph, Ont.

Leach, D. 1977a. The forelimb musculature of marten (Martes americana Turton) and fisher (Martes pennanti Erxleben). Can. J. Zool. 55:31-41.

[1]marten, morphology, musculature, Ontario
Nov 1974-Feb 1975
A comparison of the forelimb muscles of marten and fisher and a discussion of their importance for arboreal locomotion.
DATA were 25 fisher (7 male, 18 female), and 25 marten (19 male, 6 female). Both species have a strongly developed forelimb musculature, important in cursorial locomotion. Arboreal locomotion is a secondary function.

Leach, D. 1977b. The descriptive and comparative post cranial osteology of marten (Martes americana Turton) and fisher (Martes pennanti Erxleben): The appendicular skeleton. Can. J. Zool. 55:199-214.

[1]marten, morphology, Ontario, osteology, sex determination
Nov 1973 - Feb 1974
The adult appendicular skeletons of fisher and marten were compared

to determine characteristics that may distinguish between species and between sexes.

DATA were 26 fisher (8 M, 18 F), and 25 marten (19 M, 6 F). Inter-sexual differences were greater for fisher than for marten. The skeleton of both species is unspecialized, it resembles that of the domestic cat. However, the forelimb skeletal elements are more developed than in the cat, possibly due to an enhanced digging ability. In fisher, no overlap occurred between sexes in ranges of measurement of the humerus, radius, ulna, tibia, and fibula.

Leonard, R. D. 1980. Winter activity and movements, winter diet and breeding biology of the fisher (Martes pennanti) in southeastern Manitoba. M.Sc. Thesis, University of Manitoba, Winnipeg, 181p.

[1]activity, breeding behaviour, condition, diets, energetics, fat indices, foraging behaviour, forest cover, habitat use, livetrapping, management, Manitoba, natal dens, natality, radio-telemetry, reproduction, snow cover, tracking
May 1975 - June 1977 (field)
1972-1978 (carcasses)
Objectives were to describe activity, movements, selection of forest cover types during winter, winter diets, and breeding biology.

ACTIVITY: Fewest tracks were observed during January and February. This decrease in mid-winter activity appeared to be related to changes in snow cover. Changes in the use of gaits and cover types were qualitatively correlated with physical variations in snow. Open bogs with a supportive crust were used frequently but avoided during periods of soft snow. Fishers active on soft snow may use an estimated 54% more energy per day than fishers on hard snow.

WINTER DIETS (n = 120 stomachs and gastro-intestinal tracts) consisted primarily of birds (48%), snowshoe hare (36%), small mammals (17%), and sciurids (13%). Only porcupine in diets showed geographic and sex differences. With an increasing density of hares, the proportion in fisher diets increased. This appears to be a functional response by fishers to hare numbers. Use of other prey and the number of different foods also declined as the proportion of hares in the diet increased.

REPRODUCTION of females first occurred at 1 year of age. Estrus and parturition occurred in late March and April. Mean and mode corpora lutea counts for 13 pregnant females were 3.5 and 3, respectively. Testicular volume increased over the winter and all males were spermatic by March. (*See following paper*).

MOVEMENTS of a radio-collared adult female during active pregnancy were not extensive. This female whelped kits (2 seen, likely a total of 4 present) in a tree den. Intensive information on activity and movements from 13 April to 26 May, at den abandonment, were obtained. The female spent more time away from the den with increasing age of kits but did not travel further each day. She maximized the use of her former home range. These data are the first for a fisher female with kits.

Leonard, R. D. 1986. Aspects of reproduction of the fisher, Martes pennanti, in Manitoba. Can. Field-Nat. 100:32-44.

[1]litter size, Manitoba, natality, parturition, reproduction
1972-1978

Reproductive characteristics of fishers were determined from carcasses and from observations of fisher movements and behaviour during breeding

DATA were 195 carcasses from southeast Manitoba submitted from 1972 to 1978, and observations collected using radio-telemetry and tracking during March and April, 1976 and 1977. No juvenile (< 12 months) females had corpora lutea (n=81). First reproduction occurred at the end of the first year of age. Of 16 adult females, 13 (81%) were pregnant Most were young individuals (*sample sizes not given*). Mean and mode numbers of corpora lutea were 3.5 and 3. Three females had *in utero* litters of 3 kits each. Estimated dates of parturition, based on embryo development, were late March and early April. On 28 March, a radio-collared female had a litter of 4 kits in captivity, weighing 26.0, 30.0, 30.0, and 30.7 g. She whelped a litter in the wild during early April.

The epididymides of 5 adults and 2 juveniles trapped in March contained sperm. Male movements increased during March. More adult than juvenile male skulls had fractured zygomas, an injury not observed in females. It is hypothesized that during the breeding period, intra-sexual territoriality breaks down as males search for females in estrus.

Luque, M. H. 1983. Report on fisher survey-1983 for the Idaho Department of Fish and Game. Idaho Coop. Wildl. Res. Unit. Unpubl. Rep. 17pp.

Maj, M., and E. O. Garton. 1993. Distribution maps for lynx, wolverine, and fisher in the western United States. USDA Forest Service Northern Region and Univ. Idaho.

Mahaney, T. J., II, T. A. Decker, and T. K. Fuller. 1991. Cage traps and fisher harvest in Massechusetts. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

harvest, livetrapping

ABSTRACT: Cage traps have proven an effective means by which to capture fishers (Martes pennanti) for research and reintroduction programs. However, to the best of our knowledge, nothing has been reported regarding the effectiveness of using cage traps to harvest fishers commercially. Massachusetts has restricted the use of conibear traps only to water sets since the early 1960's, and steel-jaw leghold traps only to drowning sets since 1975. As a result of these restrictions, and because there is no hunting season for fishers, trapping with cage traps has become the primary method of harvesting fishers in the state.

Examination of Massachusetts harvest data from 1980 to 1988 revealed that 71% of all fishers harvested were taken with cage traps, 23% with leghold traps, 4% with conibear traps, and 2% by other means. Over this 9-year period, total harvest of fishers rose from 115 to 248, the number of trappers harvesting at least 1 fisher increased from 49 to 69, the mean number of fishers harvested per successful trapper increased from 2.35 to 3.59, and the number of towns in which at least 1 fisher was harvested increased from 43 to 74. In addition, density of fisher harvest in two fairly distinct areas of 300 and 1,700 km^2 each reached as much as 7-13 animals/100 km^2 of forested habitat. These rates are on par with fisher harvest rates in several other New England states where fishers are harvested primarily with conibear traps.

Despite being more bulky and expensive than other traps, cage traps have the advantage of protecting the captured animals from predators and scavengers, thus

preventing damage to the fur. More significantly, cage traps appear to be just as effective as other traps for commercially harvesting fishers.

Monson, R.A. and W.B. Stone. 1976. Canine distemper in wild carnivores of New York.

Morse, W. B. 1961. The return of the fisher. Am. For. 67(4):24-26, 47.

[1]Idaho, livetrapping, Montana, Oregon, popular account, reintroduction
A 3-state program to re-establish fisher in the Pacific Northwest is announced.

Fisher were obtained from British Columbia. Montana completed the program in 1960, transplantation is underway in Oregon and Idaho is hoping to begin during 1961-62. Logistics of the Oregon program are discussed.

Mullis, C. 1985. Habitat utilization by fisher (Martes pennanti) near Hayfork Bally, California. M. S. thesis, Humboldt State Univ. 91pp.

ABSTRACT: Habitat utilization, individual range and movements, and effects of logging on fisher (Martes pennanti) were studied near Hayfork Bally in Trinity County, California. Fishers were live-trapped, immobilized, fitted with radio telemetry collars, and released. Location data were obtained from trapping, track observations, and from air and ground radio telemetry. Field sampling of habitat at fisher locations and U.S. Forest Service timber type maps were used for analysis of habitat utilization.

Five males and three female fishers were captured during the study. Four were juveniles and the other four were adults. Mean home range size for all fishers was 16.6 km^2. Mean home range size for males was 26.7 km^2 compared to 6.5 km^2 for females. Adult males had the largest home ranges. Adult female ranges were smaller than male ranges. Overlap of home range was common. There was no relationship between individual home ranges and gross topographical features. Adult males tended to move outside of their ranges during the rut.

Open areas were used less frequently by all sex and age classes. Adults were not often found in the relatively early successional timber type grouping described as small conifer/conifer non-commercial. All fishers considered together showed nearly significant ($p < 0.1$, $n = 8$) selection for the mixed conifer/hardwood timber types and adult fishers strongly selected for the mature closed conifer timber type. Adult fishers used the elevational range of 457-1219 m, and juveniles used the 914-1829 m elevational range. Riparian areas may be important habitat for fishers.

Novak, M., J. A. Baker, M. E. Obbard, and B. Malloch (eds.). 1987. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, 1150p.

[1]**Over 100 authorities present aspects of the biology, trapping and management of North American furbearers.** Fishers are discussed with respect to trapping techniques, pelt quality, fur grading, life history, harvests, management etc.

O'Meara, D. C., D. D. Payne and J.F. Witter. 1960. Sarcoptes infestation of a fisher. J. Wildl. Manage. 24:339.

Obbard, M. E., J. G. Jones, R. Newman, A. Booth, A. J. Satterthwaite, and G. Linscombe. 1987. Furbearer harvests in North America. Chapt. 64, p. 1007-1034. in: M.Novak et al. (eds.). 1987. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, 1150p.

[1]furbearers, harvests, management

Trends in North American harvests and underlying factors are discussed.

The decline in fisher harvests, from the 1840s to the 1940s was due to extensive habitat losses and local extirpations following settlement. The 20-th century North America harvest of fishers has been low compared with the harvests of other furbearers, and it appears that factors other than economic ones are responsible. Protective legislation, habitat improvement and reintroductions have restored fisher populations to much of their original range. North American harvests in the 1970s and 1980s have been much higher than peaks observed in 1790s and 1840s. The increase reflects increased demand and high pelt prices, but also appears to indicate an increase in population sizes.

Olson, H. F. 1966. Return of a native. Wisconsin Conserv. Bull. 31(3):22-23.

[1]popular account, re-establishment, Wisconsin

The decline in porcupine populations in Wisconsin and Michigan forests is attributable to the re-establishment of fishers.

Olson, H.F. 1966. Return of a native. Wisconsin Conserv. Bull. 31(3):22-23.

Pack, J. C. and J. I. Cromer. 1981. Reintroduction of fisher in West Virginia. Worldwide Furbearer Conf. Proc., Frostburg, Maryland. Vol. II:1431-1442.

[1]dispersal, habitat, reintroduction, West Virginia

In 1969, 23 fishers (from New Hampshire) were reintroduced into West Virginia. The releases, public reaction, and trapping regulations are discussed. The maximum distance moved was 90 km, and the mean distance 44 km. The majority of observations occurred in suger maple - beech - yellow birch and red spruce cover types, with no major expansions into oak - hickory habitat. Fisher are currently re-established in the state.

Paragi, T. F, Krohn, W. B., and S. M. Arthur. 1991. Estimates of fisher recruitment and survival and their management implications. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

Based on thesis work; see Paragi 1990

Paragi, T. F. 1990. Reproductive biology of female fishers in southcentral Maine. M. Sc. Thesis, Univ. of Maine, Orono. 107pp.

activity, age determination, behavior, dispersal, harvests, home range use, lactation, litter size, Maine, management, mortality, movements, natal dens, natality, parturition, radiotelemetry, reproduction, spatial patterns, thesis

The best study of reproductive behavior and ecology of fishers, with examination of a diverse array of related topics from natality to harvest management.

ABSTRACT: The reproductive biology of 12 radio-collared female fishers (Martes pennanti) ≥2-yrs-old (adult) was studied from February 1984 to December 1989 in a 600 km^2 study area in southcentral Maine. Twelve adult females were monitored, 7 for ≥1 year, for 25 fisher-seasons (season = March-June). Estimated whelping dates (n = 12 litters) were 3 March-1 April (median = 21 March, interquartile range = 14-29 March). Use of natal dens typically began during mid-late March and ended during early June. Kits generally stayed within the mother's home range until being trapped in November (1 male) or dispersing in January (2 females). Intensive monitoring during 1988-89 caused females to move kits more often than during 1986-87, but no kits were abandoned.

All natal dens occurred in tree cavities (n = 33). Hardwoods composed 94% of the dens examined, 1986-89, with aspens (Populus spp.) accounting for 52% of all den trees.

Annual rate of natal denning by adult females averaged 60% (range 0-100%). Five litters in natal dens averaged 2.0-2.2 kits per female, 1988-89. Survival rate of kits from ca. 6 weeks until late October was a minimum of 0.6. Estimated rate of fall recruitment was 0.7-1.3 kits per female, substantially less than ovulation rate (3.0 ova per female ≥1 yr).

Proportion of adult females with placental scars (75%, n = 20 fisher carcasses from central Maine, 1988-89) more closely corresponded to annual denning rates (60%) than did occurrence of blastocysts in carcasses of females ≥1-yr-old (85%, n = 41), suggesting that implantation rate is less than ovulation or fertilization rates. Teats on female fishers that suckled young (n = 7) were larger than those on a female that had not suckled young, suggesting that the proportion of adults with enlarged teats could be an annual index to the proportion of females raising young.

Average annual survival rate [95% CL] was 0.69 [0.54, 0.88] for females ≥1 yr and 0.19 [0.08, 0.47] for juveniles of both sexes. Average annual fall recruitment needed to maintain the population (2.1 kits per female) was greater than the observed rate (0.7-1.3), suggesting a population decline. Annual estimates of population increment were <1.0 except when annual survival of females ≥1 yr was 1.0 in 1986. Catch per unit effort for September-October livetrapping (1985-89) and catch rates of successful trappers (1977-88) were consistent with the estimated population decline. The fisher harvest in southcentral Maine should be reduced to allow population recovery.

Parsons, G. R., M. K. Brown and G. B. Will. 1978. Determining the sex of fisher from the lower canine teeth. New York Fish and Game J. 35:42-44.

[1]New York, sex determination
1975, 25 Oct - 31 Dec
Two tooth measurements, root width and root thickness of the lower canine, are used to estimate age class of fishers

Data were 247 trapped fishers (98 M, 149 F). Mean root width was 6.44 +/- 0.300 mm (range 5.9-7.0) for males, and 4.85 +/-0.298 mm (3.4-5.7) for females. Mean root thickness was 4.80 +/- 0.432 mm (3.4-6.0) for males, and 3.58 +/- 0.262 mm (3.0-4.7) for females. Using a maximum root width of 5.6 mm (P=0.955) as a dividing point, 148 of 149 females and all 98 males were sexed correctly. Using a

maximum root thickness of 4.0 mm (P=0.955), 147 of 149 females, and 94 of 98 males were sexed correctly.

Peterson, R.L. 1966. The mammals of eastern Canada. Oxford University Press, Toronto. (fisher) p. 256-259.

Pittaway, R. J. 1978. Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Le Naturaliste Canadienne. 105:487-489.

[1]activity, feeding behaviour, Ontario (Algonquin)
3 winters, 1974-1977

Direct observations of fisher behaviour during winter included chasing of a snowshoe hares (n = 2), and eating frozen baits at artificial feeders. Powerful jaw muscles allow fisher to be an efficient scavenger. Peak activity at an artificial feeder occurred at late afternoon and continued through the night to approximately 1 hour after sunrise. Two resting sites, under man-made structures, are described.

Pittaway, R. J. 1984. Fisher, Martes pennanti, scent marking behaviour. Can. Field-Nat. 98:57.

[1]feeding behaviour, Ontario (Algonquin), scent marking
During January 1980, a male fisher was observed marking a deer carcass with urine.

Powell, R. A and R. D. Leonard. 1983. Sexual dimorphism and energy expenditure for reproduction in female fisher Martes pennanti. Oikos 40:166-174.

[1]energetics, lactation, reproduction, sexual dimorphism
A model to estimate energy expenditure of female fishers during lactation was developed. The model is applied to data from an adult female with kits in Manitoba (Leonard 1980).

The non-reproductive energy expended by a 2.64 kg female during early lactation is predicted to be approximately 970 kJ/d when kits are 13-56 days old. Lactation requires 542-1006 kJ/d, approximately 40% of the total energy expended. Other costs increase from 899 to 1330 kJ/d, due to an increase in activity by females when securing food for kits. When kits are 7 weeks old, 2270 kJ/d are required, 2.3 times the needs of a non-reproducing female fisher. Since weaning is incomplete until kits are 10 weeks old, the energy expenditure could reach 2500-2900 kJ/d, almost 3 times the non-reproductive expenditure.The large energy output required for reproduction explains why selection favours smaller size in females. The energy expenditure of females and males is predicted to be the same during reproduction.

Powell, R. A. 1977. Hunting behaviour, ecological energetics and predatory-prey community stability in the fisher (Martes pennanti). Ph.D. Thesis, University of Chicago, Illinois. 132p.

[1]activity, behaviour, diets, energetics, forest cover, habitat, hunting behaviour, metabolism, Michigan, morphology, optimal foraging, porcupine, predator-prey, resting sites, snowshoe hare, weights
1973-1976

The thesis is the original study for most succeeding papers. Methods

included observations of live and captive fishers, snow tracking, and radio telemetry. There are 4 chapters: I. Fisher natural history and general biology, II. A comparison of fisher and weasel hunting behaviour, III. Ecological energetics of fishers during winter and IV. Stability in a one-predator-three-prey community.

I. Morphology, classification, evolution, distribution, reproduction, and behaviour of fisher were reviewed. Behaviour was studied by following tracks. Fishers were also livetrapped and radio collared. Eight were retained in captivity. Fishers were predominantly terrestrial but climbed trees occasionally. Activity was determined using continuous radio monitoring. Fishers were active both day and night and had a small number of activity periods (1-3), lasting 2-5 hours. Of 31 temporary resting sites, 10 were snow dens, 9 hollow logs, 8 holes in the ground, 2 holes in trees, and 1 a hollow stump. One radio-collared female stayed in a rockfall for 3 days.

II. Fisher hunting behaviour was compared to that of weasels. Thirty-three weasel and 33 fisher tracks were followed. Killing behaviour was studied from tracks and observations of captive animals. Weasels foraging for mice and fishers foraging for snowshoe hares changed direction frequently and attempted to flush prey from cover. Fishers foraging for porcupine travelled long distances (up to 5 km), seldom changed direction, and oriented foraging toward porcupine dens. Fishers avoided habitats with no cover. Fishers killed porcupine by attacking the face. Diets were estimated by the analysis of 35 scats. Snowshoe hares, porcupines, white-tailed deer (carrion), and mice were the most frequent prey items.

III. A model for the daily energy budget of fishers was developed and parameters determined from metabolic studies. Oxygen consumption was recorded for fishers running on a treadmill. Active and inactive fishers had metabolic rates slightly higher than the average for all mammals. Estimates of daily energy expenditure for free living, radio-collared fishers ranged from 200 to 450 kcal. An optimal foraging strategy model for fisher was developed. Search time and energy available were the most important factors in determining optimal foraging for a predator with 2 distinct habitats in which to forage.

IV. Five models of fisher predator-prey communities were developed and applied to 1-predator-1-prey and 1-predator-3-prey fisher communities. Stability was investigated using community matrices and simulation. All model communities were stable; 3-prey communities were in general more stable than 1-prey communities. Lack of competition between prey may explain this result. Fisher and porcupine should maintain a stable predator-prey relationship

Powell, R. A. 1978. A comparison of fisher and weasel hunting behaviour. Carnivore 1(1):28-34.

[1]diets, hunting behaviour, Michigan, porcupine, snowshoe hare
see Powell 1977, Chapt. II.

Powell, R. A. 1979. Ecological energetics and foraging strategies of the fisher (Martes pennanti). J. Anim. Ecol. 48:195-212.

[1]activity, energetics, Michigan, optimal foraging
see Powell 1977, Chapt. III.

Powell, R. A. 1979. Fishers, population models, and trapping. Wildl. Soc. Bull. 7:149-154.

[1]management, Michigan, mortality, population models, predator-prey, trapping
A computer simulation of the effects of increased mortality due to trapping on fisher populations (also see Powell 1977, Chapt. IV).

Five predator-prey models were investigated. At equilibrium population levels, the mortality increase causing fisher extinction was equivalent to from less than 1 to 4 additional fisher per 100 km^2. Thus, only small increases in fisher mortality above natural levels may cause local fisher extinction. "Only well established and widespread fisher populations should be trapped". The (present) decline in fisher in northeastern U.S. may also be due to a low in the hare cycle.

Powell, R. A. 1979. Mustelid spacing patterns: Variations on a theme by Mustela. Zhurnal Tierpsychol. 50:153-165.

[1]home range, sexual dimorphism, spatial patterns

Spatial patterns and home range sizes of mustelid s are reviewed. Intrasexual territoriality is supported for fisher. There is a strong correlation between the degree of intrasexual territoriality, sexual dimorphism in body size, degree of body elongation, and degree of carnivory. Energy requirements may tie these correlations together.

Powell, R. A. 1980a. Stability in a one-predator-three-prey community. Am. Nat. 115:567-579.

[1]deer, Michigan, porcupine, population models, predator-prey, snowshoe hare
see Powell 1977, Chapt. IV.

Powell, R. A. 1980b. Fisher (Martes pennanti) arboreal activity. Can. Field-Nat. 94:90-91.

[1]behaviour, Michigan, movements
1979, January
Movements of a fisher through the tops of trees in a hardwood forest are documented and reports in the literature are reviewed. Arboreal activity of fishers has been exaggerated.

Powell, R. A. 1981. Hunting behaviour and food requirements of the fisher (Martes pennanti). Third Worldwide Furbearer Conf. Proc., Frostburg Maryland. Vol II:883-917.

[1]behaviour, energetics, foraging, habitat, Michigan, porcupine, snowshoe hare
1972-1979

Fisher foraging and killing behaviours were studied during winter in the Ottawa National Forest. Open bogs, muskegs, meadows, pipelines and large logging roads were not used by fishers, snowshoe hare, or porcupine. Fishers always ran across open spaces. Daily energy expenditure of fishers is modelled using activity variables which yield estimates of 200-600 kcal per day. (see also Powell 1977, Chap. III).

Powell, R. A. 1982. The fisher: Natural history, ecology, and behaviour. University of Minnesota Press, Minneapolis. 217p.

[1]**A summary of the fisher literature and an extensive coverage of Powell's research.** Although the book was written for a general audience, considerable technical information is included. Only major headings cited here.

Chap. 1. THE FISHER. Name, description, classification, evolution, the fisher's ecological niche, study techniques.

Chap. 2. ANATOMY. Post-cranial skeletal and muscular systems; teeth, skull and related musculature; brain.

Chap 3. LIFE HISTORY AND EARLY DEVELOPMENT. Breeding season; male reproductive biology; female reproductive biology; courtship and mating; denning; delayed implantation; neonates and early development; longevity, disease, parasites, and mortality.

Chap. 4. PAST AND PRESENT DISTRIBUTION AND POPULATION DENSITY. Population decline; reintroduction and recovery; population densities.

Chap. 5. GENERAL HABITS, HOME RANGE, AND MOVEMENTS. Home range; habitat; activity and movements; sleeping sites; arboreality; swimming.

Chap. 6. FOOD HABITS. Characteristics of the fisher's diet; the fisher's prey; diet analysis by season and sex.

Chap. 7. HUNTING AND KILLING BEHAVIOUR OF FISHERS HUNTING PREY OTHER THAN PORCUPINES. Hunting behaviour; killing behaviour.

Chap. 8. THE FISHER-PORCUPINE SYSTEM. The porcupine; fishers and porcupine; fishers and quills.

Chap. 9. ECOLOGICAL ENERGETICS OF THE FISHER. Energy acquisition and expenditure; sexual dimorphism in body size and energetics; energy expenditure and reproduction; energetics and foraging strategies.

Chap. 10. CONSERVATION AND THE FISHER'S RELATIONSHIP TO HUMANS. Interactions with humans; the value of the fisher; fishers in captivity; the fisher's future.

Powell, R. A. 1991. Structure and spacing of Martes populations. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

behavior, home range use, predator-prey

ABSTRACT: Limited data on unexploited Martes populations indicate that sex ratios are probably close to 50:50, age structures are seldom, if ever, stable, and population sizes fluctuate with those of important prey. Trapping biases hinder studies of natural populations and cause exploited populations to differ significantly from unexploited populations.

Home range sizes vary greatly within and between species of Martes, due in part to use of different methods, in part to biases in some methods, and in part to true variation. Within each species in a single location, males' home ranges are larger than those of females and home range sizes increase with body size. Why males have home ranges larger than females is not well understood but is hypothesized to be caused by female home range size being dependent on food abundance and distribution while male home range size may also be dependent on spacing of females.

An economic model of territorial behavior predicts that the intrasexual territoriality found in many Martes populations is allowed because prey distributions are patchy and prey become temporarily invulnerable after a predator has foraged in a patch. As prey populations vary from very low to very high, Martes spacing is expected to change from nomadism to individual territories, to intrasexual territories, and to lack of territories and extensive home range overlap. Intrasexual territories may benefit males by decreasing time needed to find females and by decreasing the probability of not mating. Females appear to gain no benefits from sharing home ranges with males.

For a fisher (Martes pennanti) population in Upper Peninsula Michigan, USA, the number of prey habitat patches visited daily was found to be a small proportion of the total number of prey habitat patches in a home range. When this is the case, the length of time that prey remain invulnerable after perceiving a predator has little effect on fisher spacing behavior. The range of prey availability that allows individual territories should be small for most fisher, and other Martes, populations. However, if fishers were to visit a large proportion of their home ranges daily or if prey behavior were changed for a day or more, intrasexual territoriality would be less likely to occur.

Powell, R. A. and R. B. Brander. 1977. Adaptations of fishers and porcupines to their predator prey system. in: Phillips, R.L. and C. Jonkel (eds.). 1977. Proceedings of the 1975 Predator Symposium. Montana Forest and Conservation Experimental Station, University of Montana, Missoula, p. 45-53.

[1]Michigan, porcupine, predator-prey, prey switching, snowshoe hare
The significance of fisher-porcupine interactions in Michigan was determined. (A significant interaction for porcupine means that porcupine populations are smaller and more stable than without predation by fishers; for fisher, it is better for the energy requirements of fisher to prey on porcupine.

Fishers were introduced in the study area during 1961-1963. Porcupines were censused in 1961 and each year from 1969 to 1975. The porcupine population declined 76% over 13 years on a 178 ha study area. Both porcupine and fisher are endemic to North America and have a self-regulating predator-prey system. Fisher switch between porcupine and snowshoe hare. Habitat configuration, the placement of food trees in relation to den trees for porcupine, is an important factor affecting the rate of predation.

Proulx, G. and M. W. Barrett. 1991. Managerial and ethical considerations in the selection of traps to harvest marten and fisher. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

harvest

ABSTRACT: Marten (Martes americana) and fisher (Martes pennanti) are valuable

furbearers and, because they are easily trapped, their populations are frequently in decline. Wildlife agencies try to avoid overharvesting by shortening trapping seasons or reducing quotas (e.g., 1 fisher/registered trapline in Alberta). However, marten and fisher trapping receive public criticism because most jurisdictions permit the use of trapping devices which cause non-lethal and painful injuries, or from which seriously injured animals may escape and die away from the trap site. Foothold traps used as live-holding devices for marten (No. 0 or 1) or fisher (No. 1-1/2 and 3) are not "humane" because they seriously injure the animals. Furthermore, wring-offs are known to occur and may result in death, but they are rarely taken into account in wildlife management programs. These losses could represent up to 15% of the known annual harvest. When populations are depressed and strict quotas must be enforced, such losses have the potential to compromise the recovery of populations and jeopardize wildlife management programs. Killing devices are also used to harvest marten (foothold No. 3 and 4 and Conibear 120 and 160) and fisher (Conibear 160 and 220). However, these traps are not "humane" because they do not consistently render animals rapidly (≤3 min) unconscious, even when the animals are struck in vital regions. The public concerns regarding marten and fisher trapping deserve attention and traditional trapping devices should be replaced by the best available "humane" traps. Box traps should be used to selectively harvest populations that are small or in decline. When box traps cannot be used, "humane" killing traps should be the mandatory alternative. The C120 Magnum is the only capture-efficient trap known to consistently render marten unconscious in ≤3 min. It has met the highest standards in trap technology and is now commercially available. In the case of fisher, the Conibear 220 trap should be maintained until potential "humane" traps such as the Bionic mousetraps are fully tested and available. The mandatory use of escape proof "humane" traps is vital to the future of marten and fisher management programs involving trapping activities.

Proulx, G., A. Kolenosky, M. Badry, R. Drescher, K. Seidel, and P. Cole. 1991. Reintroduction of fisher in the Parklands of central Alberta. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

Alberta, dispersal, habitat use, movements, radiotelemetry, reintroduction

ABSTRACT: In an effort to reintroduce fisher (Martes pennanti) in central Alberta, 9 adults (6 females and 3 males) were released in March, and 8 more (5 females and 3 males) in June, 1990. The study area consists of deciduous forests, pastures, farmlands, and wetlands. After a 12-month period of captivity for behavioral studies, the radio-collared animals were transferred to continuous forest stands and released after a 5-7 day period of acclimation. In March, release sites were saturated with beaver (Castor canadensis) carcasses to incite the animals to remain near the sites.

Twenty-four hours after their release, the March fishers were significantly ($P < 0.05$) further away (1.5 to 8.5 km) from their release sites than the June animals (0.1 to 3.5 km). During the following month, the average distance between the animals and their release sites increased and was again larger ($P < 0.05$) in March (9 to 31 km) than in June (2 to 12 km). Also, the average distances travelled by the animals between the radio-locations were greater ($P < 0.05$) in March (8 to 16 km) than in June (2 to 7 km). Vegetation inventories of sites used by fisher during the month following their release suggest that in March, fishers used mainly deciduous woodlots surrounded by wetlands and grasslands. Most of the locations in June were in continuous deciduous forest stands.

Three of the fishers released in March slipped off their collars and 4 died. Deaths were attributed to intraspecific fight wounds and other trauma of unknown origin in 2

males, predation (bird of prey) and roadkill. In June, 1 animal lost its collar but none were killed. The March release, because of the extent of the animal movements (possibly related to the breeding season) and the lack of vegetation cover, did not result in a successful reintroduction. In contrast, the June release resulted in the settlement of 7 animals nearby their release sites, in continuous forest stands.

Quick, H. F. 1953. Wolverine, fisher and marten studies in a wilderness region. Trans. 18th North Amer. Wildl. Conf., 513-532.

[1]British Columbia (Fort Nelson), density, habitat, harvests, movements, harvest sex ratios, wolverine

A survey of the fur resources of the Fort Nelson region, 1947-1948.

The study area was in the Taiga Biome (spruce forests, white birch, aspen), and subject to intense trapping. Three physiographic subdivisions were recognized: muskeg, foothill and mountain. Density estimates were based on tracking and harvests. Fisher were most numerous in the mountain subdivision. In 1947, 26 fisher and 24 wolverine were harvested. "Populations of fisher and wolverine in Fort Nelson region seemed to be roughly equivalent". Thus, considerable area was not occupied by fisher (*wolverine have home ranges at least 10 times as large as fisher*). Muskeg areas appeared to be rarely frequented. A pre-trapping density (1947) was 1 fisher / 208 km^2, or approximately 250 fisher for the region. In 1947, harvest sex ratios were 5 M : 12 F, and in 1948 3 M : 5 F.

Raine, R. M. 1981. Winter food habits, responses to snow cover and movements of fisher (Martes pennanti) and marten (Martes americana) in southeastern Manitoba. M.Sc. Thesis, University of Manitoba, Winnipeg. 145p.

[1]behaviour, diets (winter), foraging, habitat use, home ranges, marten, mortality, Manitoba, movements, resting sites, sinking depth, snow cover

Results of a trailing and radio-telemetry study in boreal forest habitats.

August 1978 - August 1980

Leonard (1980) provided the background for this study. Marten were not present in the study area before 1978 and were an invading population. Relative prey densities (red squirrel, grouse, snowshoe hare) were determined by track counts, small mammal trapping, and scats. Porcupine were rare and muskrats were common. Carrion was available in the form of beaver, moose, and caribou. No deer occurred in the area.

WINTER DIETS: Fisher and marten diets were determined (from 159 and 107 scats, respectively) and compared. Snowshoe hare were at a high in their cycle during the study and constituted the major prey in fisher scats (84%). Other prey were egg (7%), grouse (7%), marten (5%), mice and voles (3%), marmot (2%), and red squirrel (1%). In tracking studies, fishers averaged 1 kill or scavenge (hare, grouse, eggs, squirrel, small mammal) per 5.1 km of trail. Martens displayed more subnivean and arboreal behaviour than did fishers.

HABITAT USE: The physical effect of snow on fisher was examined by recording paces and sinking depth. Tracks were counted and compared to expected if fisher used habitats proportional to availability. All habitats were sampled haphazardly (by "feel"). Api-profiles of snow stations, for the top 10 cm, were determined. Three

periods of snow cover were delineated, a) first snowfall, to 20 cm, b) midwinter, <100 g/cm^2, and often <10 g/cm^2, and c) crust conditions, >100 g/cm^2. The change from b) to c) was often abrupt.

During the first winter, 65 tracks were observed. More tracks were found than expected on rivers and lakes during a), and more tracks on coniferous ridges during b). During c), habitats were used in proportion to their availability. Fishers used snowshoe hare or their own tracks more often during b). Fishers left long furrows in the snow, often up to 25 cm wide and 10 cm deep. Marten never left furrows. Fishers sank less in snow cover on rivers and lakes than on coniferous ridges. Coniferous ridges were also used by prey species.

HOME RANGES AND MOVEMENTS: Six fishers (2 M, 4 F)and 10 marten were radio-collared; all fishers were juveniles. The midwinter home range of the 2 females was 20.5 km^2 (45 locations in 64 days) and 15.0 km^2 (25 locations in 24 days). Mean distances moved between daily locations were 1.1 km (n=32) and 2.5 km (n=18) for the 2 females.

RESTING SITES: Seven subnivean resting dens were observed, 6 in jackpine ridge habitat, and 1 in black spruce bog. Three were under boulders, 3 were under upturned tree roots, and 1 was in the spaces between branches of fallen birch. One den was used sporadically for at least 30 days.

MORTALITY: A young male may have died of starvation. The effects of midwinter snow cover on mortality of fisher are unknown.

Raine, R. M. 1982. Ranges of juvenile fisher, Martes pennanti, and marten, Martes americana, in southeastern Manitoba. Can. Field-Nat. 96:431-438.

[1]home range, Manitoba, marten
abstracted from thesis, see Raine 1981

Raine, R. M. 1983. Winter habitat use and responses to snow cover of fisher, Martes pennanti, and marten, Martes americana, in southeastern Manitoba. Can. J. Zool. 61:25-34.

[1]habitat use, Manitoba, marten, sinking depth, snow cover
abstracted from thesis, see Raine 1981

Raine, R. M. 1987. Winter food habits and foraging behaviour of fishers, Martes pennanti, and martens, Martes americana, in southeastern Manitoba. Can. J. Zool. 65:745-747.

[1]behaviour, diets (winter), foraging, marten, snowshoe hare, tracking
abstracted from thesis, see Raine 1981

Raphael, M. G. 1984. Wildlife populations in relation to stand age and area in Douglas-fir forests of northwestern California. Pages 259-371 in Meehan, W. R., T. R. Merrell Jr., T. A. Hanley, eds. Fish and wildlife relationships in old-growth forests. Amer. Instit. Fishery Res. Biol. (Publ.)

Annotation to be added

Raphael, M. G. 1991. Techniques for monitoring populations of martens and fishers. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

techniques

ABSTRACT: Martens and fishers are secretive forest-dwelling carnivores that are difficult to observe and study. These species are believed to be associated with late-successional forest; martens are used as ecological management indicators of old-growth conditions in a majority of National Forests of the western United States. Because these species are of special concern to forest managers, reliable monitoring techniques and protocols are needed. Techniques used to date include habitat surveys, trapper reports, snow tracking, baited track stations, hair snares, and camera systems. Of these only camera stations seem to offer advantages of consistent results across large geographic areas, ease of identification (photographs are generally unambiguous), low to moderate cost (supplies for camera stations can total as little as $10-12 per station, including film and processing), and ease of use by inexperienced observers.

In this paper I review advantages and disadvantages of each technique and provide examples of how each has been used by managers or researchers. In addition, I review how each technique can be used in relation to objectives of monitoring. These objectives range from establishing presence of a species as part of a distributional analysis to more complex designs to establish multi-year trends in relative abundance. For small-scale, presence-absence surveys, choice of technique and experimental design is not critical. Considerations in such designs include spacing and timing of stations, sampling duration, and use of lures or baits. Statistical considerations include variance of detection probabilities, power analysis for detecting trends, and analytical options.

Rego, P. W. 1984. Factors influencing harvest levels of fisher in southcentral and southeastern Maine. M. S. thesis, Univ. Maine, Orono. 53 pp.

Rhoads, S. N. 1898. Contributions to a revision of the North American beavers, otters and fishers. Trans. Am. Phil. Soc., new series, 19:417-439.

[1]taxonomy, subspecies

Using an "inferior series of skins and skulls", the subspecies M. canadensis pacifica is designated (5 skulls, 2 skins examined). (The fisher initially was named Mustela canadensis Schreber). Characteristics are a large size, in body and skull. Some colour differences reported. Distribution is the Pacific Slope, from Alaska to California.

Rosenberg, K. V. and M. G. Raphael. 1986. Effects of forest fragmentation on vertebrates in Douglas-fir forests. Pages 263-272 in Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Univ. Wisconsin Press, Madison.

Rosenzweig, M. L. 1966. Community structure in sympatric Carnivora. J. Mamm. 47:602-612.

[1]marten, mustelids, predator-prey
A theoretical examination of niche overlap in sympatric carnivores.

Different body sizes allow sympatric mustelids to consume different sizes of prey. Fisher diets consist more of prey in the 50 - 150 g size, and marten diets, 0 - 50 g size. Marten diets are less diverse than diets of fisher. The sympatric coexistence of the 2 species is due to different degrees of specialization.

Roy, K. D. 1991. Ecology of reintroduced fishers in the Cabinet Mountains of Northwestern Montana. M. Sc. Thesis, Univ. of Montana, Missoula 94 pp.

activity, deer, diets, dispersal, habitat use, litter size, management, Montana, mortality, movements, natal dens, radiotelemetry, reintroduction, snow tracking, snowshoe hare, thesis
Studied post-release movements, mortality, and habitat use of radio-tagged fishers during the first 2 years of a 4-year reintroduction effort in northwestern Montana (also see Heinemeyer 1993).

ABSTRACT: As part of a reintroduction program, 32 fishers (Martes pennanti) were imported from Minnesota and released in the Cabinet Mountains of Northwest Montana in 1988-90. All fishers were radio tagged and soft released; 12 were released on 1 January 1989, 15 released 1 January 1990, and 5 released 9 March 1990. Fishers were monitored until June of each year and were radio relocated a total of 531 times. Fishers ate mostly snowshoe hares (Lepus americana) and deer (Odocoileus sp.) carrion. Fishers were active at all times of the day and night, and no clearly defined activity patterns were noted. At least 9 of the 32 fishers were killed by predators, 3 were killed by trappers, and 2 died from unknown causes. Twelve of the 14 dead fishers were healthy prior to death. Males had a higher mortality rate than females. At least 2 fishers gave birth in the study area and 1 became pregnant, but all 3 died before the kits weaned. No fisher developed a true home range during the monitoring period. Distances between standard locations (3-5 day intervals) were short in January and February, but increased in the breeding season of March and April. Habitat selection included mostly young, dense mixed conifer stands.

The habitat and prey base in the Cabinets Mountains seems sufficient to allow fisher survival; however, high mortality and emigration rates, and no documented reproduction, present major problems to fisher recovery. Instead of immediately dispersing from the study area, the fishers waited until the breeding season in March and April to begin long distance movements. Fisher reintroductions in areas of apparently suitable habitat but with new and diverse predator complexes may have a low potential for success. Management recommendations include: obtain fishers from a nearby geographic location, an earlier release date, the release of females with kits in April, continuation of soft release procedures, release of approximately equal sex ratios, the development of a core population, and appropriate protection.

Roy, K. D. 1991. Factors affecting fisher reintroduction success in the Cabinet Mountains of northwest Montana. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

Based on thesis (see above)

Scheffer, V. B. 1938. Notes on wolverine and fisher in the state of Washington. Murrelet. 19(1-2):8-10.

[1]distribution, wolverine, Washington, habitat
Observations and trapper records of fisher and wolverine in Washington.

Reports of fisher are concentrated chiefly in the wild and roadless portions of the Olympic Mountains. Fisher have been observed along the Cascade Mountains and as far east as the Okanogan valley. A report of arboreal behaviour is included. One young male was trapped in 1917 at an elevation of 1650 m.

Schempf, P. F., and M. White. 1977 (ms). Status of six furbearer populations in the mountains of northern California. U.S. Dept. of Agriculture, Forest Service, California Region, 51p.

[1]California, distribution (map), elevations, habitat
Observations dated from 1960 were used to determine distribution and habitat use of fishers in northern California.

Fisher in California are most closely associated with mixed conifer and Douglas-fir cover types. In the North Coast Region, 48% of 108 sightings were in Douglas-fir, and 38% in mixed conifer types. In the South Sierra, sightings occurred primarily in mixed conifer types. Fisher were observed in open areas such as clearcuts, grass/sage/juniper, and chaparral habitat types. Fishers use lower elevations than do marten. The North Coast Region currently sustains the densest population of fishers in California. Fishers are rare in the North Sierra and the South Sierra. The "fisher habitat in California is similar to that described in British Columbia by Edwards and Cowan (1957)".

Seton, E. T. 1926. Lives of game animals. Vol II, Part II. Order Carnivora or Flesh-eaters. Life XXXII: The fisher. p. 451-479.

[1]diets, distribution, habitat, harvests, skull, taxonomy
Seton's seminal studies of life history are well known. Selected results are presented.

HARVEST: During a March sale in Winnipeg in 1904, prime fisher pelts brough $4-$9. During 1906 in London sales, prime pelts brought $12. In 1919-20, the "fur boom", the average price of fisher pelts was $84, with choice pelts bringing $125, and $150. Average prices in the 3 seasons 1920-21 to 1923-24 were $59, $74, and $70. The record price, during 1920, was $345.

HABITAT: The fisher is a forest animal. It seems to prefer swamps, especially among large timber. Natal dens are often in hollow trees, 9-12 m off the ground. Dens were also found in logs and rocky crevices. Fishers use habitats similar to raccoon. They frequent damp swampy areas, stagnant pools and shallow lakes where they prey on reptiles, fresh-water molluscs and crustaceans, and small fish. Fishers are often seen swimming rivers and lakes.

DIETS: Fishers are omnivorous, eating berries, beach nuts, and rose-hips. Snowshoe hare are a favourite food. The fisher will steal marten out of traps. It can kill fox, lynx, marten and deer. The dependence on porcupine has been written about as early as 1829. Caching of food is common.

Shea, M. E., N. L. Rollins, R. T. Bowyer and A. G. Clark. 1985. Corpora lutea number as related to fisher age and distribution in Maine. J. Wildl. Manage. 49:37-40.

[1]harvests, Maine, natality, reproduction
1978-81, October - November
Results of a carcass study.

DATA were reproductive tracts from 355 carcasses. Of 141 pairs of mature ovaries (females _ 1 year in age), 95% had corpora lutea. Corpora lutea were present in ovaries of 93% of 86 1-year olds and 86% of 22 2-year olds. All fishers 3 years and older had ovaries with corpora lutea. The mean number of corpora lutea per adult fisher was 3.0 +/- sd 1.04, range 0-5. Fishers aged 4-8 years had the greatest number of corpora lutea, a mean of 3.8 +/- 0.8. Corpora lutea counts did not differ among 5 ecological regions of Maine.

Stevens, C.L. 1968 (ms). The food of fisher in New Hampshire. New Hampshire Dept. of Fish and Game, Concord New Hampshire. 29p.

Stone, W. and W.E. Cram. 1905. American animals. Doubleday, Page, and Co., New York. P 241-242.

Strickland, M. A. 1991. Harvest management of fishers and martens. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

harvests, management

ABSTRACT: Fishers and martens are valuable furbearers, which can be overharvested unless carefully managed. They are attracted to baits and easily trapped, they have high pelt prices that make them desirable to trappers, and they have relatively low recruitment. Adequate population census techniques on which to base allowable harvests are not available or cost effective to use on a large scale. Therefore, other methods must be used to monitor harvest rates and to set targets.

The objective of harvest management is to produce a sustained yield by exploiting the unproductive young animals and preserving the breeding stock. Juveniles and males are more vulnerable to trapping than adult females in both fishers and martens; therefore, they are the first to be captured. If trapping pressure can be controlled, the harvest can be biased to juveniles.

Because of the differences in vulnerability of juveniles, males, and females to trapping, the age and sex ratios of harvested animals can be used to predict harvest rate. Knowing the harvest rate and number of animals harvested, the size of the population from which the harvest was taken can be calculated. This method can be applied to any harvest scheme. However, it is not predictive, and allows only *post facto* management.

This paper review methods used to regulate harvests (seasons, limits, refuges) and ways to monitor harvests to ensure a sustainable resource.

Strickland, M. A., and C. W. Douglas, M. K. Brown, and G. R. Parsons. 1982a. Determining the age of fisher from cementum annuli of the teeth. New York Fish and Game J. 29:90-94.

[1]age determination, techniques
The first documentation of a correspondence of cementum lines in

teeth with known ages in fishers.

DATA were from 8 known-age fishers (2 M, 6 F). Six were born and raised in captivity and 2 were raised as kits. Tooth sections, mainly premolars, provided 14 age determinations, representing time intervals of 7-53 months. The first cementum annulus, which apparently forms during winter, was discernable at about 15 months. After that, the number of annuli corresponded exactly with the age of the fisher in years from July through March.

Strickland, M. A., and C. W. Douglas, M. Novak, and N. P. Hunziger. 1982b. Fisher. in: Chapman, J.A. and G.A. Feldhamer (eds.). Wild mammals of North America: Biology, management and economics. Johns Hopkins University Press, Baltimore Md. p. 586-598.

[1]activity, age ratios, age determination, behaviour, breeding, density, description, distribution, diets, gestation, habitat, harvests, harvest sex ratios, home range, litter size, management, morphology, mortality, natal dens, parasites, parturition, reproduction, resting sites, review
An extensive literature review of fisher biology and management. A more recent and detailed version is Douglas and Strickland 1987.

Strickland, M. A., and C. W. Douglas. 1981. The status of the fisher in North America and its management in southern Ontario. Third World Wildlife Furbearer Conf., Proc., Frostburg Maryland. Vol. II:1443-1458.

[1]Canada, distribution (map), harvests, harvest age ratios, harvest sex ratios, Ontario, porcupine, reproduction, reintroduction
1972-1980
Indices to trapping intensity are reported.

DATA were more than 1,200 carcasses collected from a 13,600 km^2 study area and an additional 1800 from contiguous areas. The fisher population had been reintroduced during 1957-1963 and was being monitored. Times of light and heavy harvests were identified. During periods of overharvest, the ratio of juveniles / adult female (> 24 mo) was <4 and the harvest sex ratio was biased to females. During underharvest, the ratio of juveniles / adult females was >4 and the sex ratio was 1:1. It is hypothesized that in a pretrapping population, the ratio of juveniles / adult females is 2:1 and females outnumber males because of intraspecific strife and mortality between males. In underharvests, juveniles and males are taken above their occurrence in the population, and at a sex ratio of 1:1. In overharvests, juveniles and males occur in the harvest in proportion to their occurrence in the population. Raw numbers of fisher harvested by province and for Canada from 1969-70 to 1978-79 are included.

Thomasma, L. E. 1988. A test of the habitat suitability index model for the fisher (Martes pennanti) in the Upper Peninsula of Michigan. M.Sc. Thesis, Michigan Technical University, Houghton Michigan, 24p.

[1]habitat suitability index (HSI), management, Michigan, track census
1985-86, 1986-87
The first (publicized) verification of Allen's (1983) HSI model.

The study area was in the Ottawa National Forest (the location of R.A. Powell's

research). The fisher is protected in Michigan and the study population was unharvested. Habitat use during winter was determined by quantifying habitats at fisher tracks, along systematic transects. HSI's were determined using 2 methods, plot measurements of habitat variables and remote sensing coupled with U.S. Forest Service maps. The model was not falsified with the plot dats but was with the Forest Service data. Fishers used habitats with high HSI values more frequently than expected and fisher habitat preference was positively correlated with HSI values. However, the predicted HSI values within pine plantations were higher than what fisher used.

Thomasma, L. E., T. D. Drummer, and R. O. Petersen. 1991. Winter habitat use of the fisher in Michigan. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

habitat use, Michigan

ABSTRACT: A study to assess winter habitat usage vs. availability for the fisher in Michigan was conducted from 1985-1987. A systematic grid of transects was established in the study area. On each day of field work during the winter months, a randomly chosen transect was walked by the observer. A fisher location was defined as an intersection of the transect and fisher tracks, which resulted in 132 locations over the course of the study. At the point of intersection, 262.7-m2 plot was classified into 1 of 9 possible cover types. During the summer months, a total of 497 plots, located at 180-m intervals along the same transects, were classified as to cover type.

Based on a contingency table analysis, the distribution of cover types utilized by fisher differed significantly from the available cover type distribution. Fisher usage and availability were then compared for each of the 9 cover types. Northern hardwoods with conifer closure greater than 50% were the only cover type where usage significantly exceeded availability. Nine percent of the available habitat plots, compared to 16 percent of the fisher use plots, were comprised of this type. The conifer component of these plots had a mean diameter at breast height of 39 cm and consisted primarily of eastern hemlock (Tsuga canadensis). There was no significant difference between fisher use and availability within hardwoods lacking conifer closure.

Todd, A. W. 1991. Ecology and management of fisher and marten populations in Alberta. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

Alberta, diet, harvest, management

ABSTRACT: During the past 25 yr populations of both fisher and marten have reached the highest apparent levels recorded in Alberta. The marten population has remained at relatively high levels through 1990, although showing evidence of a 3-4 yr cycle; the fisher has apparently undergone a major population decline during the latter part of this period, as indexed by annual fur harvests and large-scale trapper surveys (n = 1,241 - 1,667 trappers annually during 1987-1989). Available information indicates that fisher numbers in Alberta follow the 10 yr cycle of the snowshoe hare (Lepus americanus), but with a 2-3 yr lag; however, fisher abundance has not resurged with that of the hare during 1985-1990, possibly a result of over-exploitation.

Examination of gastrointestinal tracts of animals trapped during 1974-1977 indicated that microtine rodents, snowshoe hare, Cervidae (carrion), and grouse were

dietary staples for the fisher, whereas microtines and avian remains predominated in marten tracts. Fat reserves were more common and extensive in fishers, particularly for males, but were not shown to vary either over-winter or among years for either species, within sex and age classes. The breeding rate (% pregnant) for yearling fishers (83%) and corpora lutea counts were low compared to recently published values (1.7 yr.: mean = 3.0, s.d. = 1.0; ≥2.7 yr.: mean = 3.1, s.d. = 0.5). This possibly reflects a relative food scarcity during a hare low, although recruitment improved ($P < 0.005$) during 1975-1976, as hare abundance began to increase. Among martens, female fecundity was high, with evidence of juvenile breeding during 1976-1977, a peak year in marten fur harvests.

A preliminary analysis of spatial and temporal trends in fur harvest during 1971-1989 indicates a shrinking in fisher distribution in recent years. It appears that management must be intensified for fisher in Alberta and other jurisdictions in western Canada. A "tracking strategy" of managing harvests is required, where rates of harvest are adjusted to ranges of population increase.

van Nostrand, N. 1979. Report from Nova Scotia in Trans. of fisher workshop held at Leslie M. Frost Nat. Res. Center, Dorset, Ontario, October 21-23, 1979.

Vucetich, J. A., L. E. Thomasma, and R. O. Peterson. 1991. Dietary overlap in male and female fishers and pine martens of Minnesota. Abstract from the Symposium on the Biology and Management of Martens and Fishers. Laramie, Wyoming.

competition, diet, Minnesota

ABSTRACT: The extent to which interspecific and intraspecific competition drives the evolution of body size in similar species may be reflected in the degree of dietary overlap. Differences in body size among similar species may decrease dietary overlap effectively reducing exploitative competition. If inter- and intra-specific competition is a driving force in the evolution of relative body size in male and female fishers and pine martens, as a means to reduce exploitative competition, then dietary overlap will be related to differences in size between these species and between each sex within each species. To test this hypothesis 200 stomach and intestine samples from male and female fishers and pine martens will be analyzed for food content. Then the dietary overlap of male and female fishers and pine marten will be analyzed, and compared to relative differences in body size. After examination of 50 gastrointestinal tracts, preliminary results suggest fisher depend more on white-tailed deer and snowshoe hare, and marten depend more on microtines and insectivores. Discernment of dietary differences between the sexes of fishers and martens will require further analysis.

Weaver, J. 1993. Lynx, wolverine, and fisher in the western United States: Research assessment and agenda. USDA forest Service Intermountain Research Station Contract No. 43-0353-2-0598. Missoula, Montana.

management, population models, predator-prey, reestablishment, refuges, review, spatial patterns, United States

An assessment of information about lynx, wolverine, and fisher from a research perspective and a proposed agenda of studies designed to provide information regarding habitat relationships and population viability

EXECUTIVE SUMMARY: Conservation of forest carnivores - particularly lynx (<u>Felis lynx canadensis</u>), wolverine (<u>Gulo gulo</u>), and fisher (<u>Martes pennanti</u>) - has

emerged as a major issue in several western States involving numerous National Forests. The population status of these furbearing animals is either unknown or perceived as declining whereas their relationships with habitats and prey in the West are poorly understood. The purpose of this report is to present a comprehensive research assessment and agenda for conservation of lynx, wolverine, and fisher in the western United States.

Establishing the context is essential in assessing a research 'problem'. A wildlife species begins a downward slide when its population becomes reduced in size and/or distribution due (most often) to systematic factors such as habitat loss and/or overexploitation. As habitat fragmentation progresses and the subpopulations become smaller and more isolated, they become ever more susceptible to random or stochastic factors including demographic, genetic, environmental, and catastrophic. To the degree that such subpopulations are connected via dispersers, the entire assemblage may be considered a metapopulation.

Lynx, wolverine, and fisher have certain characteristics that render them susceptible to such pressures. They are medium-sized carnivores requiring large areas for individual home ranges which results in naturally low densities. Although wolverine tend to be generalists in diet and habitat, lynx are specialized predators of snowshoe hares. Each of these species has comparatively low fecundity that, as a corollary, requires high adult survivorship for population persistence. These species are renown for their vulnerability as individuals to trapping. Lynx, wolverine, and fisher occur primarily throughout the boreal forest of North America. As we trace their peninsular distribution along the major mountain ranges into the western United States, most of these constraints become more acute due to increasingly restricted area of suitable habitat at the southern margin of their geographic range. Here, they appear vulnerable at local and regional scales due to natural limitation exacerbated by human pressures on populations and habitats.

The challenge, then, is to secure populations that are viable (certain likelihood of persistence for a defined time period) at some spatial scale. To accomplish this goal, managers must: (1) arrest the decline in habitat and populations due to systematic pressures, and (2) build resilience against stochastic changes that impinge on the viability of small populations. Based on an extensive review of the literature and discussions with experienced biologists, I assessed our current state of knowledge about prey/habitat relationships and population viability of these species at a variety of hierarchial scales.

To manage for prey and habitats of these furbearing carnivores, it's necessary to know the (1) principal prey species, (2) habitat relationships of important prey, (3) distribution, abundance, and dynamics of the key prey populations, (4) foraging and denning habitat of the predator, and (5) influence of prey base on home range size.

A review of these furbearers' diets revealed that (1) snowshoe hare is a 'multiple linkage/keystone' prey species, particularly for lynx and fisher, and (2) ungulate carrion is a bonanza (if unpredictable) food, whereas diversity of prey provides foraging options for the two mustelids. The composition and structure of vegetation comprising food and cover for snowshoe hares within patches has been described in general. If we visualize the cover/forage requirements of snowshoe hares in dimensions of composition-space-time, then we see that hares in the western United States actually have a narrow range of habitat suitability. The value as snowshoe hare habitat of many vegetation types and successional stages found in the Rocky Mountain and Pacific Coast regions remains unknown. An important characteristic of western forest landscapes is their natural and induced heterogeneity (fragmentation), even at the scale of snowshoe hare home ranges. Little is known about the effect of such landscape heterogeneity upon snowshoe hare habitat suitability. The classic 10-year cycle of snowshoe hare in the North has been investigated thoroughly. In contrast, very little is known about the status and dynamics of snowshoe hare

populations in the western United States. Although the few studies suggest that hare densities in this part of their range are low and do not fluctuate dramatically, they have been too localized and too short in duration to reliably assess snowshoe hare abundance over space and time. This information would have important implications for habitat capability and population ecology of lynx and fisher.

Selection of habitats at a micro-scale for foraging and denning has been documented for lynx and wolverine (to a lesser extent) in the North and for fisher in the East. In contrast, there have been few studies of habitat relationships of these furbearing carnivores in the western part of North America. Lynx often use early-successional plant communities at high elevations for foraging, and mature to 'old-growth' forests with downed timber for denning and possibly for foraging. Fisher in the Rocky Mountains also use mature and older forests with high ground coverage of large logs and coniferous and deciduous understory. The wolverine remains the least-studied of the larger carnivores in North America.

It is habitat selection at the macro- or landscape scale, however, where our knowledge about these wide-ranging carnivores is most limited yet where research findings may be most instructive. Home range of adult females - as an expression of the space necessary to fulfill energetic requirements for reproductive success - is the fundamental building block for higher levels of population viability. Due to their niches as hunters of patchily-distributed prey, these furbearing carnivores have extraordinarily large home ranges relative to their body size. Adult female home ranges vary from 3-fold up to 10-fold within a study. What is the effect of natural/anthropogenic fragmentation of prey patches upon the foraging and breeding success and home range size? Due to reliance on snowshoe hare that, in turn, leads to well-defined prey/habitat patches, lynx (and, to a lesser extent, fisher) would be a model carnivore for studying the effects of habitat fragmentation.

In the western U.S., lynx, wolverine, and fisher have declined to the point of extirpation in some portions of their native range while recolonizing other areas; currently, they are scattered in small subpopulations. One might assume that, because lynx, wolverine, and fisher are protected at present by state legislation/regulation or harvested at extremely low, a *de facto* system of refugia currently exists. Some incidental taking, though, may be occurring. Many furbearer managers in North America believe that some form of temporal and/or spatial refugia is prudent and perhaps necessary for persistence and sustainable harvest of furbearer populations. The role of refugia in population persistence has emerged as one of the most robust concepts of modern ecology. Much remains unknown, however, in terms of the actual size, dispersion, and spato-temporal dynamics for effective refugia.

The process of modeling and analyzing the various systematic and stochastic processes affecting the fate of a population has been termed *population viability analysis* (PVA). Key variables in a PVA include (1) initial population size and carrying capacity, (2) natality, (3) mortality, (4) immigration/emigration via dispersal, and (5) influence of environmental variability on these demographic parameters. Deficiencies in knowledge about each of the primary population variables for these furbearers in the western United States are woefully apparent. One of the most obvious and serious shortcomings, though, is simply the lack of information about current population sizes and carrying capacities for disjunct subpopulations. This points out the urgent need for estimates of habitat capability as well as improved monitoring techniques.

If it turns out that individual subpopulations have low to moderate likelihood of persistence, then management at the metapopulation level on a regional basis will be necessary. What would be the effect of different sizes, shapes, and juxtaposition of suitable habitats across the Rocky Mountains and Pacific Coast ranges on the persistence of these furbearer populations? What factors influence successful

recolonization and/or restoration, and what effect does this have on persistence of the metapopulation? Given the context of natural and anthropogenic fragmentation of landscapes at the southern margin of their geographic range, a formal Population Viability Assessment for lynx would illuminate such important issues.

In areas where natural recolonization is unlikely, translocations can serve two basic purposes: (1) augmentation of an existing isolated subpopulation to enhance its demographic size or structure as well as its genetic heterozygosity, and (2) restoration of a strategic subpopulation to increase the viability of the metapopulation. Little is known about the actual mechanics to improve chances of successful translocations. A unique opportunity currently exists for re-introduction of captive-reared lynx in the Rocky Mountains. If feasible, such an approach would have advantages of a reliable, regional source of inexpensive animals for re-introductions where the need has been established through a regional Population Viability Analysis and status surveys. Finally, as experiments, re-introductions can have the additional benefit of enhancing research through more precise knowledge of initial populations and larger sample sizes.

Based upon the current status of lynx, wolverine, and fisher in the western United States and the assessment of current knowledge about their prey/habitat relationships and population viability, I have identified the following list of 10 priority research studies.

1. Habitat relationships of snowshoe hare in western ecoregions

2. Role of habitat heterogeneity in long-term population dynamics of snowshoe hare

3. The role of gleaning networks in wolverine ecology and habitat use in central Idaho (*adjunct to J. Copeland's study)

4. Prey and habitat selection by fisher in the Pacific Northwest

5. Effects of habitat/prey fragmentation on movements and home range of lynx, wolverine, and/or fisher

6. Population viability analysis: building a regional strategy for lynx conservation

7. Feasibility of using captive-born lynx for reintroduction

8. Persistence of metapopulations: Factors affecting success of recolonization and reintroduction

9. Role of refugia in fisher conservation: An experimental approach

10. Role of refugia in sustainable furbearer harvests: Simulation modeling of source-sink dynamics.

Weckworth, R. P., and P. L. Wright. 1968. Results of transplanting fishers in Montana. J. Wildl. Manage. 32:977-980.

[1]dispersal, movements, Montana, reintroduction

During 1959-60, 36 (16M, 20F) fishers from British Columbia were released in western Montana. Females trapped the following year were reproducing normally.

Females were recovered 55-56 km from release points. Two males travelled at least 72 and 102 km.

Williams, R. M. 1962. The fisher returns to Idaho. Idaho Wildl. Rev. 15(1):8-9.

[1]Idaho, reintroduction
The first phase of a reintroduction of fishers is documented. Decline of fishers in the state may have been due to overtrapping, non-selective predator control, and reduction of habitats due to settlement, logging and fires.

Wright, P. L. and M. L. Coulter. 1967. Reproduction and growth in Maine fishers. J. Wildl. Manage. 31:70-87.

[1]age determination, Maine, natality, parturition, reproduction, skull, weights
1950-1964, October - April
Results of a carcass study originating in Coulter 1966.

DATA were from 204 carcasses. All females greater than 1 year in age were pregnant. Adult females trapped in January, February, and March (n = 9) had implanted embryos. Parturition is estimated to mostly occur in March but may range from February to April. Counts of corpora lutea (n = 44 females) averaged 3.28. Females bred for the first time at 1 year of age. Juvenile females were distinguished from adults by open sutures in the skull during the first year of age. Juvenile males were recognized in early fall by open sutures in the skull, no saggital crest, lighter weight of bacula, and unfused epiphyses. The saggital crest begins development in December and often is well developed by March. By February, overlap in weights of bacula occurred between juveniles and adults. Males showed active spermatogenesis at 1 year. Carcasses averaged 0.819 of whole weights (*see also Coulter 1966*).

Yocum, C. F. and M. T. McCollum. 1973. Status of the fisher in Northern California, Oregon and Washington. Calif. Fish and Game 59:305-309.

[1]California, Oregon, Washington, distribution

Records of fisher observed or trapped in these states are presented. Fisher occur in northwestern California, records for Oregon are primarily in the southwest, and in the west (but not on the coast) in Washington.

PART IV: REPRINTS

INTRODUCTION

A selected set of papers has been included to provide additional information on fisher ecoogy and management. Because of the length of theses and dissertations, these were not included. The following is a list of titles included in the set; the complete citation can be found in the bibliography:

Jones and Garton (1994). Selection of successional stages by fishers in north-central Idaho

Arthur et al. (1989). Home range characteristics of adult fishers

Arthur et al (1989). Habitat use and diet of fishers

Kuehn (1989). Winter foods of fishers during a snowshoe hare decline

Freel (1991). A literature review for management of the marten and fisher on National Forests in California

Allen (1983). Habitat suitability index models: fisher

de Vos (1951). Overflow and dspersal of marten and fisher from wildlife refuges

Berg (1983). Reintroduction of fisher, pine marten, and river otter

Strickland and Douglas (1981). The status of the fisher in North America and its management in southern Ontario

Raine (1987). Winter food habits and foraging behaviour of fishers and martens in southeastern Manitoba

USFWS (1991). Notice of 90-day finding on petition to list the Pacific fisher as endangered

Unknown. How fisher went to the skyland - the origin of the Big Dipper (Anishinabe)

28 Selection of Successional Stages by Fishers in North-Central Idaho

Jeffrey L. Jones and Edward O. Garton

Predicting the effects of forest management on fisher (*Martes pennanti*) populations requires an understanding of their habitat relationships, as well as such characteristics as movements, size of home ranges, and food habits. Allen's 1983 habitat suitability index model was designed to aid managers in evaluating the effects of habitat alteration on fishers, but the model was based on data from eastern North America and is probably not appropriate for western habitats. Little is known about the ecology and behavior of fishers in western North America. Only two studies have described habitat relationships of fishers in California (Buck 1982, Mullis 1985), and none have been conducted in the northern Rocky Mountains. Our study investigated and attempted to explain habitat-use patterns of fishers in north-central Idaho.

Study Area

We conducted our study in the Nez Perce National Forest, Idaho County, Idaho. Boundaries of the area were roughly the South Fork Clearwater River to the south and west, Meadow Creek to the east, and the Selway River to the north. The specific study area of about 1010 km² was defined by the home ranges of 13 radio-collared fishers. Elevations within this study area range from 1006 m to 2165 m.

Most forests within the area are in the grand fir (*Abies grandis*) and subalpine fir (*A. lasiocarpa*) vegetation zones (Cooper et al. 1987). Grand fir habitat types (Cooper et al. 1987) dominate the area (75.9%), whereas subalpine fir, Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and lodgepole pine (*P. contorta*) habitat types occur on approx-

imately 16.7%, 5.0%, 1.8%, and 0.6% of the area, respectively. Other tree species present in the area include western larch (*Larix occidentalis*), Engelmann spruce (*Picea engelmannii*), and a few western red cedar (*Thuja plicata*). Pacific yew (*Taxus brevifolia*) was often a major component of the grand fir–ginger (*Asarum caudatum*) and grand fir–queencup beadlily (*Clintonia uniflora*) habitat types and commonly reached heights of 10 m.

Annual precipitation and snowfall at nearby Elk City, Idaho (1230 m), average 85 cm and 353 cm, respectively; annual maximum and minimum temperatures average 13°C and −3°C, respectively (Pierce 1983). Winter snowpacks during our study ranged from about 0.5 m at lower elevations to more than 2.0 m at higher elevations. The study area is generally covered by snow from early November through mid-April.

Methods

Capturing Fishers. Fifty cage-type livetraps baited with meat scraps and scented with a commercial attractant were placed along a trapline at locations expected to have a high trapping success. Trap intervals varied from about 3 km to 12 km. We trapped from 1 September through 15 April, although some trapping occurred during summer. We checked traps daily except when snow conditions delayed inspection. We sometimes set traps in areas where noncollared fishers had been observed.

Captured fishers were immobilized with ketamine hydrochloride (Hash and Hornocker 1980). Anesthetized animals were weighed, measured, sexed, tattooed, aged according to sagittal crest development (Wright and Coulter 1967), examined for external parasites and physical abnormalities, and fitted with 78-g radio collars.

Locating Fishers. We located radio-marked animals from fixed-wing aircraft and from the ground, but to ensure accuracy we used only ground locations for habitat analyses. Owing to difficulties in locating animals, a precise sampling design was not used. We tried to locate animals twice each week and to obtain 30 or more observations per animal per season. To increase the independence of observations, we did not record locations if the animal was relocated within eight hours of its previous observation. We approached to within 10 m of resting animals before observations were recorded. Consequently, error polygons (Mech 1983) for resting fishers were generally less than 0.05 ha. In summer, active animals were generally approached to within 80 m, resulting in an error polygon of less than 1 ha. Winter locations were also determined by back-tracking fisher tracks in

snow. When back-tracking, use sites were recorded at 500-m intervals, and were assumed generally to be hunting observations.

Habitat Availability. The study area was defined by pooling all observations of the fishers and circumscribing them within a minimum convex polygon. An adequate map depicting successional stages was not available for the study area. Consequently, habitat availability on a broad scale was estimated by randomly distributing points throughout the study area as described by Marcum and Loftsgaarden (1980). Habitat availability for individual animals was estimated by using those random plots falling within an individual's home range determined by the minimum convex polygon technique (Hayne 1949). Random points were distributed within individual fishers' home ranges to ensure that each animal had at least as many random plots as plots at used sites.

Field Methods. Each fisher location and random point was classified into one of six successional stages as described by Thomas et al. (1979)—grass-forb, shrub-seedling, pole-sapling, young forest, mature forest, and old-growth forest—on the basis of dominant and codominant tree heights, distribution of tree size classes, stand decadence, and presence of snags and logs.

We distinguished two seasonal periods, based on whether snow covered more than or less than 50% of the study area at about 1230 m. We refer to these periods as winter and summer.

Statistical Analyses. We did not use trap sites for habitat analyses because of the potential bias attributable to baiting, unless a fisher had been previously observed at a location before traps were set.

To minimize the potential Type II error rate when testing for fisher selection of successional stages, we reduced the number of habitats by combining the grass-forb and shrub-seedling types into a nonforest category (Alldredge and Ratti 1986). Chi-square tests were used to determine whether habitat use differed between sexes, seasons (summer and winter), and activities (resting and hunting). Macrohabitat selection was determined by comparing habitat use with habitat availability following the procedure of Marcum and Loftsgaarden (1980); tests were conducted with $\alpha = 0.10$ owing to the conservative nature of the Bonferroni Z statistic (Alldredge and Ratti 1986). We frequently did not have adequate sample sizes for individual animals to approximate a chi-square distribution (Roscoe and Byars 1971). Consequently, chi-square heterogeneity tests (Zar 1984) were conducted to ensure that radio-collared animals could be pooled, which effectively increased sample sizes and allowed adequate approximations of the chi-square distribution.

Results

Nine male and seven female fishers were captured and radio-collared. Of these, five males and four females had sufficient locations for macrohabitat analyses. We obtained 153 summer and 93 winter locations from these animals.

Successional Stages: Vegetation Structure

We determined habitat characteristics of successional stages by measuring overstory canopy cover, tree and snag density by size class, log volumes by size class, and understory cover of trees, shrubs, and herbs (Jones 1991). Old-growth stands were characterized by dense canopies; high densities of large-diameter trees, snags, and logs; high coniferous understory cover; and moderate deciduous understory cover. Mature stands had the highest densities of moderately large trees (34.3–47.0 cm diameter at breast height [dbh]), snags 24.1–34.3 cm dbh, and logs 14.0–34.3 cm in diameter. Ground cover of logs was also highest in mature stands. The highest densities of trees 11.4–34.3 cm dbh and of snags 14.0–24.1 cm dbh were found in young forest stands. Relatively high volumes of 14.0- to 21.6-cm-diameter logs also were found in young forest stands. Young forests had the highest understory cover of deciduous shrubs. Large-diameter trees and snags were rare in pole-sapling, shrub-seedling, and grass-forb stands. The pole-sapling stands had the greatest availability of trees 1.3–11.4 cm dbh and the lowest canopy densities of forested sites. Canopy cover in shrub-seedling and grass-forb stands never exceeded 15%.

Seasonal Use and Selection of Successional Stages

Five animals were observed nine or more times in each season (summer and winter) and were evaluated for seasonal differences in cover type use. Use of successional stages shifted significantly between summer and winter ($X^2 = 29.8$, df $= 3$, $P \leq 0.0001$; Table 28.1). Fishers used mature forests more in summer ($X^2 = 4.8$, df $= 1$, $P = 0.028$), whereas young forests were used more in winter ($X^2 = 20.7$, df $= 1$, $P \leq 0.0001$). Use of the other types did not differ between seasons ($P > 0.10$).

Sexual differences in use of successional stages during summer were analyzed for five male and four female fishers and during winter for three males and two females. Use of successional stage did not vary significantly by gender during summer ($X^2 = 3.80$, df $= 3$, $P = 0.28$) or winter ($X^2 = 2.2$, df $= 2$, $P = 0.34$). Therefore, sexes were pooled for all further analyses of successional-stage selection.

Long

Table 28.1. Selection of successional stages by fishers (*Martes pennanti*; $n = 9$) near Elk City, Idaho

Successional stage	Summer observations			Winter observations		
	Use	Random	CI[a]	Use	Random	CI
Nonforest	0	35	0.04–	0	20	0.04–
Pole-sapling	3	33	0.05–	0	24	0.05–
Young forest	12	88	0.08	39	61	0.14+
Mature forest	114	135	0.10+	39	107	0.15
Old-growth	24	23	0.08+	6	11	0.07
TOTAL	153	316	—	84	223	—

[a]90% CI = (% of random locations − % fisher use locations) ± indicated value. + = preference, − = avoidance at $P \leq 0.10$ (Z-test).

Nine fishers had 10 or more summer-use observations. Of these summer locations, 90% occurred in either mature or old-growth forest (Table 28.1). No observations of fishers occurred in the nonforest habitat type. Bonferroni confidence intervals showed significant selection or avoidance in each of the five successional stages during summer (Table 28.1). Fishers preferred the old-growth and mature forest types, and avoided the nonforest, pole-sapling, and young forest successional stages.

We observed no winter use in either the nonforest or pole-sapling successional stages (Table 28.1). In winter, fishers used young and mature forest cover types at the same intensity (46%). Use of old-growth forests dropped to less than half that of summer use. Bonferroni confidence intervals indicated that in winter, fishers preferred young forests and avoided nonforest and pole-sapling areas. We detected no selection (preference or avoidance) for mature or old-growth forests. The observed seasonal shift in use of successional stages was readily apparent when the habitat selection patterns were compared between seasons; the most preferred successional stage in winter (young forests) was avoided in summer.

Use of Successional Stages for Resting and Hunting

During summer, only six fishers were located during both resting and hunting bouts. No fishers were located in nonforested sites while resting or hunting. Summer use of successional stages differed significantly ($X^2 = 13.5$, df = 3, $P = 0.004$; Table 28.2) between resting and hunting sites for all six animals. Use of pole-sapling forests for hunting was significantly greater than for resting ($X^2 = 11.5$, df = 1, P 0.001). Significant differences between resting and hunting use of young ($X^2 = 0.5$, df = 1, $P = 0.47$),

Table 28.2. Selection of successional stages by fishers (*Martes pennanti*; *n* = 6) at resting and hunting sites during summer near Elk City, Idaho

Successional stage	Resting observations			Hunting observations		
	Use	Random	CI[a]	Use	Random	CI
Nonforest	0	31	0.05−	0	31	0.05−
Pole-sapling	0	19	0.04−	3	19	0.17
Young forest	7	64	0.10−	3	64	0.18
Mature forest	69	99	0.13+	16	99	0.24+
Old-growth	12	15	0.09	1	15	0.11
TOTAL	88	228	—	23	228	—

[a]90% CI = (% of random locations − % fisher use locations) ± indicated value. + = preference, − = avoidance at $P < 0.10$ (Z-test).

mature ($X^2 = 0.2$, df = 1, $P = 0.67$), and old-growth forests ($X^2 = 1.3$, df = 1, $P = 0.25$) were not detected.

About 92% of summer resting-site observations occurred in mature or old-growth forest, whereas no such observations occurred in the nonforest or pole-sapling types (Table 28.2). Bonferroni confidence intervals indicated that fishers chose mature forests for resting, avoiding nonforest, pole-sapling, and young forest types (Table 28.2). A significant difference between availability and resting use of old-growth forests was not detected.

Of the summer hunting observations of six fishers, about 74% occurred in mature or old-growth forests, whereas none occurred in the nonforest type (Table 28.2). Fishers used a broader range of successional stages for hunting than for resting, even though we collected fewer hunting observations. Specifically, hunting observations included the pole-sapling cover type, whereas resting observations did not. Bonferroni confidence intervals for summer hunting-site observations (Table 28.2) showed that mature forests were preferred and nonforests were avoided. Use did not differ from availability for the other successional stages.

Comparing selection patterns for resting versus hunting suggested that mature and old-growth forests were used more for resting, whereas pole-sapling and young forests were used more for hunting. Fishers avoided pole-sapling and young forests for resting sites, whereas differences in use and availability were not detected for these types for fishers while hunting. Although old-growth stands were used less for hunting than they were for resting, they were used in proportion to their availability for both activities. Mature stands were preferred and nonforest types were avoided for both activities.

During winter, only four fishers were observed in both resting sites (*n* =

52) and hunting sites (n = 19). These four animals used only three successional stages (young, mature, and old-growth forests) during winter for both hunting and resting activities. We could not detect a difference in use of successional stages by activity type (hunting versus resting, $X^2 = 0.5$, df = 2, $P = 0.80$).

Discussion

Fishers in north-central Idaho did not use habitats in proportion to their spatial availability. Our findings regarding habitat use concur with those of other studies (Quick 1953; Coulter 1966; Kelly 1977; Powell 1977, 1978; Buck 1982; Mullis 1985; Arthur et al. 1989*b*) in that fishers did not use nonforested habitats. Evidence of microtines, yellow-bellied marmots (*Marmota flaviventris*), and ground squirrels (*Spermophilus* spp.) in the diet of fishers in our study area, suggested, however, that fishers may have made forays into nonforested or sparsely forested habitats for hunting (Jones 1991). Mature to old-growth coniferous forests have commonly been considered optimal or preferred fisher habitat (de Vos 1951*b*, Coulter 1966, Ingram 1973, Kelly 1977, Schempf and White 1977, Buck 1982, Allen 1983, Raphael 1984, Mullis 1985, Rosenberg and Raphael 1986) especially in areas with deep snow (Arthur et al. 1989*b*). Our results suggest, however, that although fishers preferred mature and old-growth forests during summer, young forest was the most preferred successional stage in winter. Even though we did not detect significant selection of mature or old-growth forest in winter, these types were represented by 53% of the winter-use locations and should still be deemed important.

The observed seasonal shift in use of successional stages is further supported by analyses in which the microhabitat structure and vegetative composition also differed between summer and winter habitat (Jones 1991). Although the physical characteristics of snow cover may result in seasonal variations in habitat-use patterns (Buskirk and Powell, this volume), we believe the most plausible explanation for the seasonal shift in habitat use by fishers is a concurrent shift in prey use. Jones (1991) reported that snowshoe hares (*Lepus americanus*), voles (*Microtus* spp. and *Clethrionomys gapperi*), and red squirrels (*Tamiasciurus hudsonicus*) were the primary prey for fishers in north-central Idaho. The importance of voles in the diet may decrease over the winter with a concomitant increase in consumption of red squirrels and possibly snowshoe hares. A similar shift in prey use has been reported for American martens (*Martes americana*) (Zielinski et al. 1983). Additional

research on the habitat relationships of important prey of the fisher is needed to fully understand seasonal variation in habitat use by fishers. Until the completion of additional studies, the observed seasonal variation should not be mistaken for habitat flexibility (Buskirk and Powell, this volume).

In general, sites used in winter differed less from random sites than did sites used in summer. Compared with summer, for which we found significant selection or avoidance of all five successional stages, use in winter differed from availability for only three of five stages. Furthermore, one less successional stage (young forests) was avoided in winter. This suggests that fishers use a more diverse array of habitats and are less selective of habitats in winter than in summer. In contrast, Buskirk and Powell (this volume) suggested that fishers use a wider range of cover types in summer than in winter. These apparent contradictions in habitat-use observations may be due to differences in thermoregulatory costs, prey availability, and the effects of snow cover on habitat use among study areas from widely separated geographic areas (i.e., the northeastern United States and the northern Rocky Mountains).

Similarly, fishers appeared to use a wider variety of habitats when hunting than when resting, at least in summer. The apparently random use of the pole-sapling, young, and old-growth forests for hunting may, however, have been due to inadequate sample sizes (Dixon and Massey 1969, Alldredge and Ratti 1986). Arthur et al. (1989*b*) also reported that active fishers probably used a wider variety of forest types than resting fishers and found little evidence to suggest that hunting fishers strongly selected for particular forest types. After a review of several fisher studies, Buskirk and Powell (this volume) similarly suggested that fishers were more selective of habitats used for resting than for foraging. We found that younger-aged forests appeared suitable for hunting but were rarely used for summer resting sites. More structurally complex forests seemed to have been preferred for both activities, but simpler stand structures were used for hunting (Jones 1991).

Although fishers preferred young forests in winter, they selected localities with higher availability of large-diameter trees (≥47 cm dbh), snags (>52 cm dbh), and logs (>47 cm) relative to sites 50 m distant (Jones 1991). When using young forest stands, fishers often sought areas with at least one large tree, snag, or log that had survived the stand replacement fires from earlier in the century. Because large-diameter logs often were used as temporary dens in winter (Jones 1991), it is not surprising that fishers selected winter sites with many available logs. Thus, even though many sites used in winter were classified as young forests, they contained several characteristics commonly associated with older forests.

Management Implications

Landscape Management

Although fishers in north-central Idaho preferentially selected mature to old-growth forests, their population density and stability most likely respond to overall resource abundance (i.e., macrohabitat structure; Morris 1987, Adler 1988). Therefore, as Harris (1984) suggested, fisher habitat management must involve the management of a system of mature forests as opposed to the management of individual stands. Management at a landscape scale should incorporate a variety of young- to midsuccessional stages to promote a diversity of prey species, in conjunction with late-successional stages to provide key resting habitat. In a managed forest, the habitat factor we believe most likely to limit fisher populations is the availability and connectivity of mature and old-growth forests that provide optimal resting habitat.

Fishers in the northern Rocky Mountains have evolved under a fire regime that created numerous small openings within a matrix of mature-forested habitats. Mean fire-free intervals (mostly between surface fires) in north-central Idaho range from six years in ponderosa pine–Douglas-fir/bunchgrass areas to 40 years or more in subalpine-fir habitat areas (Arno and Petersen 1983). Consequently, timber harvest practices that mimic natural landscape patterns and processes may not be detrimental to fisher populations. In fact, conversion of some areas of older age classes to younger age classes may promote a diversity of prey species and thus have long-term benefits for fishers. On the other hand, Rosenberg and Raphael (1986) reported that fishers were very sensitive to forest fragmentation in northwestern California. Additional research on the relationships among forest fragmentation, timber management, and fishers in the northern Rockies is needed to develop a conservation strategy for this species.

In our study, fishers avoided openings and forested areas with 40% or less canopy cover (Jones 1991). Preferred resting habitat patches should therefore be linked by travel corridors of closed-canopy forest. High connectivity of preferred habitats would allow the landscape to support such wide-ranging species as the fisher (Harris 1984; Buskirk and Powell, this volume). Some evidence from our study area suggests that fishers preferred forested riparian areas for resting sites and used them extensively for traveling (Jones 1991). In addition, forested riparian sites likely provide optimal habitat for two preferred prey in our study area: snowshoe hares (Bookout 1965, Bittner and Rongstad 1982, Pietz and Tester 1983) and southern red-backed voles (Koehler et al. 1975, Koehler and Hornocker 1977, Campbell 1979). Thus, riparian forests would likely make excellent corridors to connect preferred habitats.

Stand Management

Fishers seemed to prefer large-diameter Engelmann spruce trees and hollow grand fir logs as resting sites in north-central Idaho (Jones 1991). These two species should therefore dominate stands to be managed for fisher habitat in this region. Stands containing, or adjacent to, riparian areas seem to be particularly important to fishers during all seasons (Jones 1991), and should be managed conservatively if maintaining fisher habitat is a goal.

Fishers' tolerance of habitat islands is not well understood (Buskirk and Powell, this volume). Large isolated stands probably have a lower probability of fisher presence than smaller, less insular stands. We recommend that mature to old-growth forest stands, to be considered effective fisher habitat, should be at least 51 ha and have 50% or more of their perimeter in contact with pole-sized or older forests. Stands with these attributes should have about a 70% probability of fisher occurrence (Rosenberg and Raphael 1986).

At the stand scale, fisher habitat capability would be degraded in the short term by clear-cut logging. Although we did not evaluate fisher habitat selection with respect to stand age, fishers likely would avoid clear-cut areas for at least 50 years (through the pole stage), use them occasionally for another 60–100 years, and likely not preferentially select them until the trees were 80–100 years old in the case of lodgepole pine (during winter) or 120–160 years old in the cases of mixed-conifer forests. Although we found that fishers prefer young forest in winter, it is important to note that these stands regenerated under natural circumstances, after fires. Consequently, they retained several structural characteristics— a few residual large-diameter live trees, snags, and logs—that would not be expected in most recently harvested stands.

The process of recovery of a clear-cut stand, from the standpoint of fisher habitat, could be accelerated by the following practices:

1. Retaining of an abundance (≈12.3 trees/ha) of cull grand fir trees for future den logs. The objective would be to have trees at least 45.7 cm dbh that would begin to fall 80–100 years after logging.
2. Retaining at least 54 but no more than 109 metric tons/ha of large-diameter logs. An abundance of logs should aid the recovery of southern red-backed voles, providing prey that fishers may begin to use once the regenerated stand has reached the pole stage.
3. Retaining decks of cull logs and a few slash piles for potential fisher resting sites and for habitat for snowshoe hares.

Uneven-aged management would better maintain fisher habitat at the stand level. Harvesting individual trees or small (≤5 ha) plots would likely not

reduce fisher habitat capability, and could in fact increase within-stand diversity, which might improve prey diversity and abundance.

We currently lack the information needed to develop a conservation plan for fishers in the northern Rockies. Therefore, adequate management of fishers and their habitats may require adoption of a landscape-based approach. Two advantages of a broader strategy are that it has the ability to maintain the integrity of ecological systems and that it can operate with relatively little information (Hunter 1991). Applying such an approach would require land managers to adopt a long-term, large-scale plan (Thompson and Harestad, this volume), one that would mimic natural landscape patterns and processes. This in turn would involve management that would keep certain proportions of a forest in various successional stages, together with a specific frequency distribution of various patch sizes and linkages across the landscape. Such an approach would help insure the viability of fisher populations within a managed landscape.

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